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ABSTRACT

The Mathematics Pentathlon is a tournament of mathematics games held each spring since 1979 to promote the development of mathematical concepts and skills while fostering interaction among the educational community. There are five games in each of four divisions, for grades K-1, 2-3, 4-5, and 6-7. The focus is on active problem solving and critical thinking skills for children at different ability levels. This manual for grades 4-5 first discusses problem solving, educational community involvement, the range of academic performance, and the use of physical models. Then each game is described, with mathematical content, materials, time, goals, starting procedures, game rules, and tournament rules stated, plus a reproduction of the gameboard. The games for this level are Contig 60, Juggle, Stars and Bars, Queen's Guard, and Fab. (MNS)

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***The Mathematics Pentathlon® provides recognition of those mathletes who have been successful in competing with others. The real winning spirit, however, is best exemplified by the ability of a Mathlete™ to congratulate an opponent on a game well played regardless of the outcome.***

# MATHEMATICS PENTATHLON®

A MANUAL OF
DIRECTIONS
AND
OFFICIAL TOURNAMENT RULES

DIVISION III
Grades 4-5

Developed by:
John C. del Regato
Mary E. Gilfeather
Jane A. Schwarm

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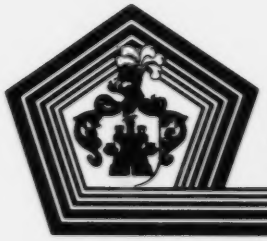

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# DEDICATION

Photo by Jimmy Mack

**David**

**Kelly**

**Tom**

**April**

***The only ladder to the stars is woven with dreams. It is never easy to keep reaching for dreams. Strength and courage can sometimes be lonely friends — but those who reach walk in stardust.***

**—Flavia Weedn**

**Photos by Eric Greulich**

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The authors would like to express their indebtedness to the thousands of students, parents, teachers, and administrators who since 1979 have shared their dream and helped them make it a reality. Each new center for the Mathematics Pentathlon® has attracted hundreds of dedicated educators as volunteers for this exciting Mathlete™ tournament.

For their dedication and for their leadership in directing past Mathematics Pentathlon centers the authors are indebted to: Carey Chappell, Emma Jean Couture, Jane Morton, Donna Nunn, John Peterson, and Stephanie Warren. The Pentathlon could not have succeeded these past years without their guidance and most generous assistance.

It is with great pleasure that we thank the many past directors of Division III for their warmhearted cooperation and assistance in refining the game rules for tournament competition. They also gave generously of their time to help orient thousands of volunteers to their responsibilities as tournament officials. We gratefully acknowledge Roger Brenneman, Helen Dubay, Mona Greenbaum, Jonathan Laabs, Terry Laubsch, Jana Reed, Stephanie Warren, and Jody Webb.

For their generous financial contributions to the development of the Pentathlon, we express our thanks to Lilly Endowment and Wickes Foundation. Without their assistance we would not have been able to develop the tournament as rapidly as we have.

From the thousands of volunteers who either gave of their time or personally supported the authors in making the tournament grow, we gratefully acknowledge the contributions of: Bea D'Ambrosia, Jeanne Angst, Darlene Adkins, Pam and Roger Barry, Sherry Bash, Ellen and Mark Bell, Dorothy Carver, Mary Chappell, Tom Clark, Richard Crowe, Diane del Regato, Juan and Inez del Regato, Sharon Emerson, Betty and James Finkbeiner, Kathleen Fleming, Nancy Goud, Christine Hayes, Sue Keene, Mark Keisling, Elaine Kemp, Paul Lindquist, Mike Metzger, Paula and Jim Minton, Vickie Moody, Robert O'Ana, Susan O'Brian, Hal Peterson, Mike Ropp, Heinz Schwarm, Wayne Taylor, Paula Weinman, Ben Wilson, Mary Jo Wright, and Barbara Young.

Lastly, we congratulate the Mathletes who enthusiastically responded to the tournament and were placed in the Hall of Fame for their outstanding achievement.

March 15, 1986

John C. del Regato
Mary E. Gilfeather
Jane A. Schwarm

I wish to express my sincere appreciation to John del Regato and Mary Gilfeather for their excellent cooperation in preparing this manual. My sincere thanks also go to Marcia Kazmierzak, Sandra Barger, Debbie Webb, Victor Wampler, Chuck Lawson, Paula Fleetwood and Betty Landrum of the PDK staff for the preparation and printing of the materials. I owe a special debt of gratitude to Willard Duckett of the CEDR Center whose constructive suggestions have made my task that much easier. Finally, special thanks to Wilmer Bugher, my predecessor, for not only identifying this program but for his excellent assistance, guidance, and support at all times.

This manual is part of the eighteenth program offered by Phi Delta Kappa's Center for Dissemination of Innovative Programs since the Center was organized in 1972.

March 15, 1986

Neville L. Robertson, Director
Dissemination Center
Phi Delta Kappa

# INTRODUCTION

## The Mathematics Pentathlon®: Problem Solving in Action

The Mathematics Pentathlon brings parents, teachers, administrators, and learners together in an educational and social event which promotes the development of mathematical concepts and skills. This tournament of mathematics games held in spring appeals to a wide range of students at different ability levels and fosters interaction among all segments of the educational community. This event is referred to as a Pentathlon because there are 5 games in each of 4 divisions. Each division consists of two grade levels: Division I - grades K-1; Division II - grades 2-3; Division III - grades 4-5; and Division IV - grades 6-7. This event focuses on active problem solving and critical thinking skills. National assessments and international studies have shown that most children lack a true understanding of mathematics on a higher level which involves the development of critical thinking skills, logical and hypothetical reasoning, discerning patterns, and seeing new relationships. With this concern in mind, professional education organizations have often emphasized problem solving and reasoning skills. Continually mounting evidence suggests that the Pentathlon offers an excellent solution to this need.

The Pentathlon was organized as a tournament of mathematics games in 1979 as a tribute to the International Year of the Child. Since then it has become an annual event in the Tri-County area (Saginaw-Bay-Midland) of Michigan. This Center for the Mathematics Pentathlon is now under the leadership of parents and educators who believe it to be a most rewarding educational experience. In 1981 a new Tri-State Center (Indiana, Kentucky, Illinois) was established in Evansville, Indiana. Over the past years both of these centers have provided parents and educators with orientation sessions and in-service education programs related to the tournament. An ever-increasing volunteer support group of teachers, parents, administrators, and students has provided the best evaluative index of the impact this tournament has made.

In 1984 the Indianapolis center for the Mathematics Pentathlon was established. At the same time the National Headquarters for the Pentathlon was organized. Also located in Indianapolis, this headquarters is responsibile for assisting other centers and establishing new ones on a national basis. Since then a number of other centers for the Mathematics Pentathlon tournament have developed. It is estimated at this writing that well over 100,000 Mathletes™ nationally are involved in practicing these problem-solving games for tournament competition.

What has caused this dramatic involvement in a problem-solving tournament? Why is the Mathematics Pentathlon growing exponentially in the numbers of individuals involved? The answers to these questions appear to lie in the unique way this tournament has approached the crisis currently faced in mathematics education. Some of the unique features of the Mathematics Pentathlon are: 1) its focus on active problem solving; 2) its involvement of the total educational community; 3) its acceptance of a broad range of academic performance levels by participants; 4) its use of concrete and pictorial manipulatives; and 5) its balanced use of non-verbal and spatial reasoning.

### Active Problem Solving

Alvin Toffler and other futurists have brought to our attention that our future is going to involve change at a rate even greater than present generations have experienced.

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This implies that future problems will involve a dynamic component which will be undergoing change even as those problems are being studied. It is clear then that a fundamental skill for dealing with the future is active problem solving, i.e., the ability to solve problems which are undergoing change during the process of attempts to resolve them.

The Mathematics Pentathlon® provides experiences in thought processes necessary for active problem solving. Through judicious use of logical analysis, spatial reasoning, computational reasoning, strategic thinking, and chance, the Pentathlon Mathlete™ attempts to resolve problems created by five entirely different two-person game events. Matched with a different opponent in each of the five tournament events, a Mathlete attempts to select a best option from a cluster of continually changing options. The Pentathlon game events rely to a great extent on the use of strategies. This provides experience in inductive and deductive reasoning through the use of systematic implementation of sequential thought. Such thought patterns are directly related to real life problem-solving situations. For example, the idea of networking is a combination of several different simultaneous approaches to the same problem.

Unlike other contests and competitions which provide individuals with static routine problems for solution by applying known algorithms, the Pentathlon focuses on non-routine types of problem-solving situations that foster the development of active problem-solving skills. But this emphasis on a dynamic approach to solving mathematical problems is not the only characteristic which makes the Pentathlon a unique experience.

## Total Educational Community Involvement

The Pentathlon games were designed so that adults as well as children would enjoy them. Just as athletic programs are often supported by the home and school, the Pentathlon nurtures home and school involvement through supporting the efforts of each Mathlete who comes to a tournament. The great interest by both adult and student may be traced in part to the dynamic problem-solving features mentioned above. Parents, teachers, and administrators have found these games to be of educational value because they cover a variety of mathematical concepts and skills such as: basic arithmetic operations, fractions, decimal arithmetic and fraction/decimal conversion, classification and logic, and tranformational geometry to name a few.

Currently there are four divisions within this tournament with each division encompassing two grade levels: Division I - grades K-1, Division II - grades 2-3, Division III - grades 4-5, and Division IV - grades 6-7. A new Division V for grades 8 and 9 is presently being constructed. Within each division there are five different games which reflect the mathematical concepts and skills appropriate for that grade level.


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During the months of August through December, parents and educators are oriented to the games that comprise the tournament. These individuals then teach their children the games at home and/or in school and prepare and select those Mathletes™ who will register for tournament competition. These same individuals also decide whether or not they will volunteer their services as one of the Pentathlon tournament officials or as one of the many volunteer assistants. Another unique feature of the Mathematics Pentathlon® is the ratio of Mathletes™ to tournament volunteers — 2:1! This type of volunteer support is only possible because of the pride and ownership that parents and educators feel toward this event.

## Representatives From a Broad Range of Academic Performance

Currently the Pentathlon consists of a total of 20 different games. Each of these games is either an original creation or some significant modification of a known game. Considerable care has been taken in designing the five different two-person games for each division. Factors which entered into the development process included: 1) creating games sensitive to the developmental differences of students; 2) providing well defined rules and instructions for tournament play; 3) designing games which support and supplement formal mathematics curricula; 4) making the games appealing to both students and adults by blending both strategy and chance within the games; and 5) emphasizing the variety of ways manipulation of physical models can be used in problem solving. The first criterion in this list has enabled the Pentathlon to attract students from a broad range of academic performance. Since the games employ non-verbal as well as the more traditional symbolic and computational aspects, many students who are strong in non-verbal or spatial reasoning abilities are attracted to the Pentathlon games which require this type of thinking. Often a child may be very skilled in this type of reasoning and yet be either disinterested and/or poorly skilled in the verbal and quantitative skills so valued within formal instructional settings. Many such students have found the Pentathlon experience to be rewarding not only because it values spatial reasoning and non-verbal ability, but because it provides a vehicle for motivating the development of logical and quantitative thinking. The child of average academic performance may also be similarly motivated. And, the student who excels academically is also challenged by the games which require multiple classification and/or geometric and spatial reasoning. The active problem-solving feature discussed above fascinates all. But, the creative use of physical models to represent the underlying mathematical concepts is yet another reason why the Pentathlon has such a broad range of appeal.

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## Physical Models

The tournament games employ a variety of educational manipulatives. Examples of such materials are pattern and attribute blocks, Cuisenaire rods, pentominoes, dominoes, and fraction bars. Although research studies have indicated the great value these and other physical models have for developing children's mathematical thinking, children often have little or no experience with these valuable learning tools.

Problem solving most typically requires the solver to build a model or create a picture of the problem. Many students have not been provided with experiences which make use of physical or pictorial models in the development of mathematical ideas. Typically these students lack the necessary imaging for resolving mathematical problems that have a spatial reasoning component. Since all of the mathematical ideas studied in grades K through 12 can be communicated using visual models, it appears most reasonable to enrich a child's experience by the appropriate use of concrete and pictorial instructional manipulatives.

Parents and educators are often surprised by the way in which physical models enable a child to investigate mathematical relationships that were not easily seen with the use of symbols alone. Parents appreciate the value of these objects as they see their child conquer the strategies used in a Pentathlon game. These parents then become most supportive of the need and use of these materials in their child's ongoing formal instruction. Teachers and administrators also gain a renewed respect for the way in which physical and pictorial models enrich the imaging related to mathematics concept development.

## The Future

It is through the efforts of many dedicated parents and teachers that the Mathematics Pentathlon® has become an established annual event. All indicators point to a bright future for this unique tournament. If you would like to see a Pentathlon, attend one of the many planned orientation sessions, or arrange your own inservice workshop, call (317) 283-6225 for further information. There is no doubt that the Pentathlon's focus on active problem solving is providing an avenue for children to experience tomorrow's mathematical skills. We can no longer look to the future through a rearview mirror. Rather than a nostalgic return to the past emphasis on the basics of arithmetic memorization and drill, the Pentathlon stresses fundamentals that are future oriented. By acquiring active problem-solving skills, Mathletes™ can look to future challenges with confidence.

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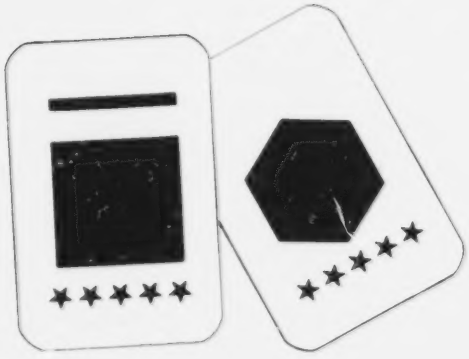
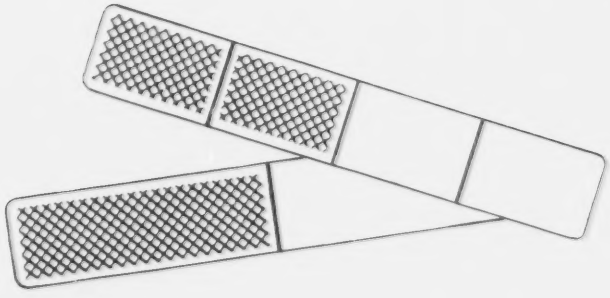
# GAMES





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# CONTIG 60™

**Created by**
**Dr. John C. del Regato**

Casting objects to see how they will fall has universally fascinated man. Modern-looking dice have been found in the ancient tombs of Egypt and date from 1500 B.C. A standard modern die is a regular cube, with six sides numbered with dots in standard configurations from 1 through 6. Any two opposing sides of a regular die add up to seven. This Mathematics Pentathlon® event involves the four basic arithmetic operations in a strategy-chance challenge to place markers on unoccupied contiguous spaces. Each Mathlete™ earns points for being successful in the strategic placement of markers. A careful examination of the numerals and their arrangement on the gameboard leads to the discovery that the probability of arithmetically constructing a certain value may differ from constructing another value. For example, constructing a 2 is more probable than constructing 50. The probabilities associated with constructing different straight-line winning paths of five chips vary relative to its position on the gameboard. A Mathlete's computational reasoning is greatly enhanced by practicing this game.

**UNDERLYING MATHEMATICS/SCIENCE:** Computational reasoning involving addition, subtraction, multiplication, division, combinatorics, probability, spatial reasoning; observation skills, deductive and inductive reasoning

**MATERIALS:** Official Mathematics Pentathlon gameboard, 25 markers of one color and 25 markers of a different color, 3 regular dice, one flag card, and paper and pencil for each player

**TIME:** Total tournament playing time is forty-five (45) minutes. Each Mathlete has one minute to complete a turn. Prior to tournament competition, when first learning the game, more time should be allowed.

**GOAL:** To win, a Mathlete must be the first to identify five markers of the same color in a straight contiguous line or have the lowest running score when a player has no more markers to place on the gameboard or when game time is called.

**TO START:**

A. Each player receives 25 markers of one color, a sheet of paper, and a pencil. Both players record 60 at the top of their sheet.

B. Each Mathlete rolls one die. The player with the lower value begins. The flag card is given to that player.

**RULES:**

1. **Alternating Turns, Placing a Marker, and Announcing Number Sentences:** Players alternate taking turns. Each player in turn tosses all three (3) dice. A number sen-

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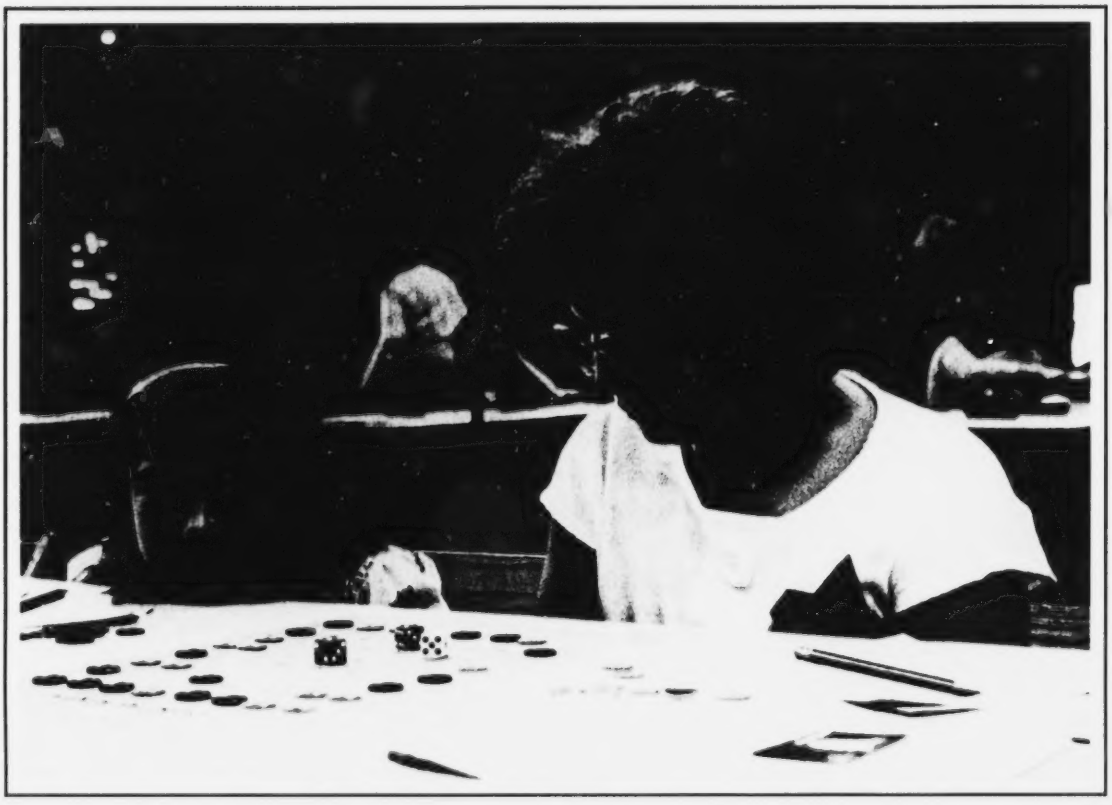
tence is constructed by using one or two arithmetic operations on the three (3) values obtained from the dice. For example, with 2, 3, and 4 a player might construct (2 × 3) + 4 = 10. In this example the player would cover the 10 space on the gameboard with a marker and announce the number sentence. Only the four basic arithmetic operations of addition, subtraction, multiplication, and division are allowed in making number sentences.

2. **Passing the Flag Card:** After stating a number sentence and placing a marker on an appropriate space, a player passes the flag card to the opposing player. The flag card is also passed to the opposing player if a player can not construct a number sentence with the values tossed in order to cover an unoccupied space on the board.



3. **Receiving the Flag Card:** After receiving the flag card, a player may pick up and toss all three dice. The player then states a number sentence that could be formed using the values on the dice and places a marker on an unoccupied space that indicates the result.



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4. **Challenge Before Picking Up Dice:** The flag card is passed to an opposing player to signal the end of a turn. Upon receiving the flag card a player must decide to pick up the dice to continue play or to challenge the other player. A challenge (see rules 15, 16, and 20) must be made before picking up the dice.

5. **Scoring and Recording Points:** One point is made for placing a marker onto an unoccupied space which is adjacent (contiguous) either horizontally, vertically, or diagonally to a space which is occupied by a marker. A player subtracts one (1) from the running score (initially set at 60) to record the event. By placing a marker onto a space which adjoins several occupied spaces, more than one point can be scored. For example, (see gameboard), if spaces 0, 1, and 27 already contain markers, a player would score three points for placing a marker in the space numbered 28. The color or ownership of the markers in adjoining spaces is not important. Points scored in such a manner are subtracted from the player's running score to give a new total. It is recommended that players not only keep an accurate record of their own running scores but that they also keep a written record of the opposing player's running score.

6. **Announcing Running Score:** Each player must announce the total running score before ending a turn (see rule 14).

7. **Marker Placed But No Points Scored:** If a marker is placed onto a space not contiguous (adjoining) to any other occupied space, no points are scored for that play and the player's running score is left unchanged.

8. **Passing:** If a player believes that no marker can be placed onto the board for the values generated by the toss of the dice, the flag card is passed to the opposing player. No points are scored.

9. **Changing Marker Position:** A player may change the position of a marker provided the player is still in possession of the flag card. Should a player do so, the corresponding number sentence must be announced. Once the flag card is passed to the opposing player, a player may not change the position of a marker on the gameboard.

10. **Dice Not Passed:** Dice are not passed from player to player, only the flag card.

11. **One Marker To A Space:** Only one marker can occupy any given space.

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12. **Holding The Flag Card:** The player must hold the flag card when completing a turn.

13. **Beginning A Turn:** A player's turn begins upon receiving and holding the flag card.

14. **End of Turn:** A player's turn ends when the player has passed the flag card to the opposing player and released hold of it.

15. **Challenging An Arithmetic Sentence Or Marker Placement:** If a player has placed a marker on the gameboard without announcing the corresponding number sentence, stated an incorrect arithmetic sentence, or incorrectly placed a marker onto the gameboard, the opposing player can challenge the play by laying the flag card down and announcing "challenge." A time out is officially recognized. If the challenge is found to be correct:

    a) the player challenged must remove the last marker placed onto the gameboard and must add back the appropriate number of points to the running score;

    b) two points are subtracted from the running score of the challenger; and

    c) the challenger picks up the flag card to signal the continuation of play.

    A successful challenger first looks for a possible play that can be made on the challenged player's toss of the dice. Before picking up the dice, the challenger may place a marker and announce the corresponding number sentence based on the values generated by the challenged player's toss of the dice. The points scored are recorded and the challenger would pass the flag card to the opposing player. If the challenger does not see a possible play, or if the challenger would like to try for a different combination of values, the dice are picked up and tossed and the challenger proceeds to find an appropriate number sentence and complete a turn.

16. **Challenging Incorrect Scoring:** A player may be challenged for incorrectly subtracting points or incorrectly announcing the player's running score total (see rules 5 and 6). If the challenger is found to be correct:

    a) the player challenged must correct the running score total;

    b) one point is subtracted from the running score of the challenger; and



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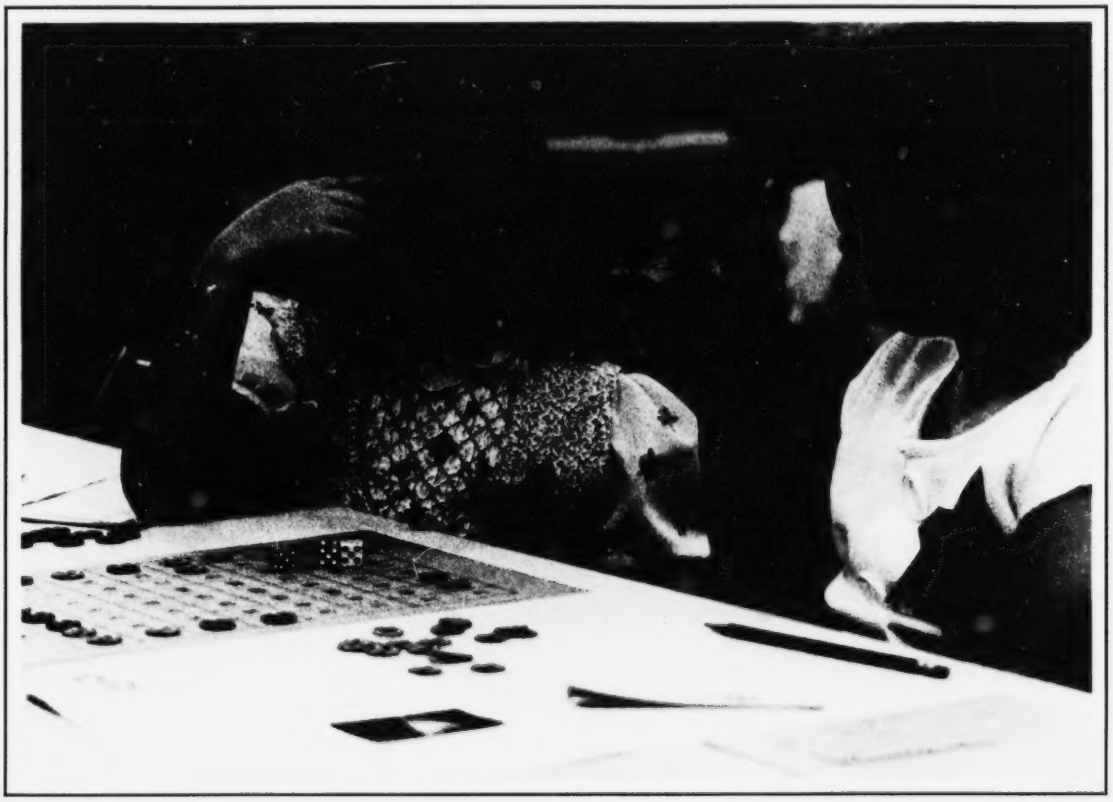
c) the challenger picks up the flag card to signal the continuation of play, picks up the dice, and tosses the dice to complete a turn.

17. **Capturing A Pass:** If a player passes the flag card believing that no play can be made on the toss of the dice, and the opposing player sees a possible play, the opposing player can proceed to capture the pass by stating a correct number sentence and placing a marker onto the appropriate space. **Twice the original score is obtained under this situation**. For example, if a player



would have typically received three (3) points for the play, six (6) is now scored and the player subtracts this amount from the running score. The player who captured the pass then proceeds to pick up the dice and toss them for a regular turn.

18. **Win/Tie/End of Game:** When a player has placed five markers of the same color on a straight connected path without an opponent's marker intervening, a win can be

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declared. The player must announce this by saying "win" or "contig" and must indicate the winning path. The winning path can be along a row, column or diagonal and the five markers must be in consecutive adjoining spaces. If neither player succeeds in aligning five markers in a contiguous path, the winner is the player having the lower running score at the end of the game or when game time is called. The end of the game occurs when a player receives the flag card but has no more markers left to play. If both players have the same running score at the end of the game a tie is declared.

19. **Winning on Opponent's Markers:** If a player fails to identify a winning path of five markers and passes the flag card to the opposing player, the opposing player can claim the winning path and announce a win. This must be done before the opposing player touches any of the dice.

**TOURNAMENT RULES:**

20. **Challenges:** If a player violates any of the preceding rules, the opposing player may issue a challenge upon receiv-


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ing the flag card. To indicate that a challenge is being made the flag card is laid down and the challenger announces "challenge." A Mathematics Pentathlon® official must rule on this challenge. In order to do so, an official time out is granted and the official asks the challenger to state the nature of the challenge. The official must rule on whether the challenge, **as stated by the challenger**, is correct or incorrect. If the challenge is found to be correct, the Pentathlon official will implement the actions described in rules 15, 16, or 21, or depending on the nature of the challenge, the official may restore the gameboard to where the markers were positioned at the beginning of the challenged player's turn. The official will then readjust the running score of the challenged player and allow the challenger to begin a turn. If the challenge is found to be incorrect, the challenger will forfeit a turn. A player forfeits the game if three consecutive incorrect challenges are made.

21. **One Minute Time Limit:** No more than one minute must elapse from receiving the flag card to passing it back to the opposing player. If a player fails to complete a turn within one minute, a Mathematics Pentathlon official will restore the gameboard and running score to where they were at the beginning of the turn and hand over the flag card to the opposing player. The player in effect forfeits that turn. The third violation of this rule results in forfeiture of the game. Mathletes™ may not challenge each other over this rule at the Mathematics Pentathlon. An official at the tournament will decide whether or not this rule is being violated.

22. **Game Time Limit:** At the Mathematics Pentathlon, if the forty-five (45) minutes of game time has run out before either player has declared a win, the Pentathlon official may allow a player to complete a turn under the following conditions. If a player has touched the dice or is in the process of constructing an arithmetic sentence when game time is called, the player will be allowed to complete that turn. If a player has just received the flag card and has not yet touched the dice when game time is called, the Pentathlon official will stop the game at that point. If no winning paths have been constructed at this time, the player with the lower running score will be declared the winner. If both players' running scores are the same when game time is called, a tie is declared.

23. **Calculators Prohibited:** Calculators are most important in mathematics problem solving. While investigating the

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possible arithmetic sentences which could generate the numerical values on the gameboard, a Mathlete may wish to use a calculator. Making a list of all possible arithmetic sentences associated with given numerical values on the gameboard helps a Mathlete™ to discover the probability of obtaining any specific value. A calculator can be most helpful in going through this process. For tournament play, however, calculators are not permitted in playing Contig 60.

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This page can be used to make an overhead transparency.

# CONTIG SIXTY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 27 | 28 | 29 | 30 | 31 | 32 | 33 | 8 |
| 26 | 54 | 55 | 60 | 64 | 66 | 34 | 9 |
| 25 | 50 | 120 | 125 | 144 | 72 | 35 | 10 |
| 24 | 48 | 108 | 180 | 150 | 75 | 36 | 11 |
| 23 | 45 | 100 | 96 | 90 | 80 | 37 | 12 |
| 22 | 44 | 42 | 41 | 40 | 39 | 38 | 13 |
| 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 |

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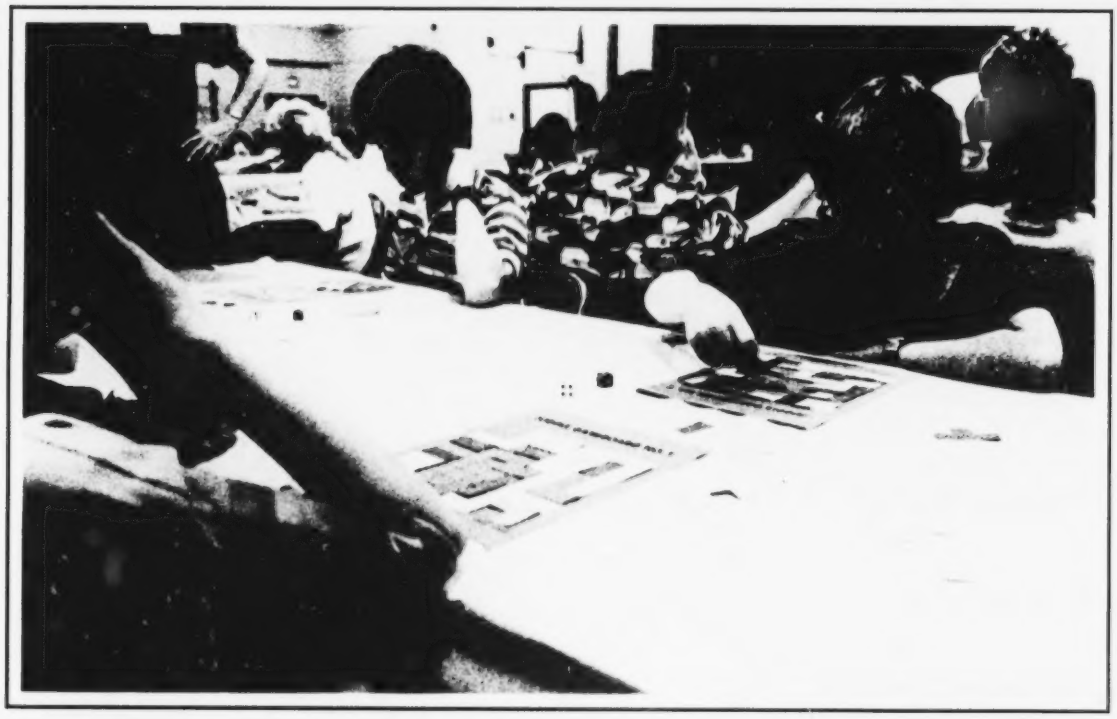

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# JUGGLE™

**Created by**
**Dr. John C. del Regato**

Juggle is a fascinating Mathematics Pentathlon® strategy game that combines skill with chance. Each player in this two-person game attempts to be the first to fill in a square area with pieces of varying shape called polyominoes. In this mathematical packing problem, a player who can visualize how certain polyominoes could be flipped or turned in order to fit into available spaces definitely has a strategic advantage. The spatial reasoning skills of imaging a partitioning of a region into component polygon regions and of visualizing transformations of geometric shapes are developed and strengthened as players attempt to juggle the playing pieces into position and to completely cover their gameboards with polyominoes. The polyominoes used in this game have metric lengths so that metric area measurement is informally experienced. The polyominoes range from four (4) square centimeters in area to twenty (20) square centimeters.

**UNDERLYING MATHEMATICS/SCIENCE:** Transformational Geometry (rotations, flips, and slides), spatial reasoning, metric area measurement, probability, estimation; observation skills, experimentation, deductive and inductive reasoning

**MATERIALS:** Two (2) Official Mathematics Pentathlon gameboards, a set of polyominoes containing twelve (12) one square pieces (monominoes), twelve (12) two square pieces (dominoes), ten (10) three square pieces (triominoes) — five each of two different types, ten (10) four square pieces (tetrominoes) — two each of five different types, twenty-four (24) five square pieces (pentominoes) — two each of twelve different types, and two (2) regular dice

**TIME:** Total tournament playing time is forty-five (45) minutes. Each player is allowed one minute to complete a turn. Prior to the tournament, when first learning the game, more time should be granted.

**GOAL:** To win, a player's gameboard must be completely covered with polyominoes so that pieces do not overlap and no two polyominoes of the same color are touching edge-to-edge or corner-to-corner.

**TO START:**

A. All polyomino pieces are spread out from a "bank" of playing pieces. They are spread out in such a way that each polyomino piece is visible and no polyomino covers another polyomino.

B. Players each toss one of the dice. The Mathlete™ with the lower toss begins.

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**RULES:**

1. **Alternating Turns:** Players alternate taking turns.
2. **Dice Toss, Piece Selection and Parts of a Turn:** Each player in turn tosses both dice. The values represented on the dice determine which two polyomino pieces a player can select and place onto the player's gameboard. Each of the two dice values represent the two parts of a player's turn. The dice values of 1, 2, 3, 4, and 5 indicate that a one-square, two-square, three-square, four-square, and five-square piece respectively is to be selected for placement.
3. **Polyomino Placement:** Selected polyominoes are placed to exactly cover the designated squares on the gameboard. Pieces are to be placed so that shapes of the same color do not touch either edge-to-edge or corner-to-corner. A polyomino may not overlap another polyomino.
4. **A Toss Of Six:** If a six (6) is tossed, any polyomino piece may be chosen either from the bank of playing pieces or from the opposing player's gameboard.
5. **A Selected Piece must be Placed:** Once a player has picked up a piece from the bank or from the opponent's

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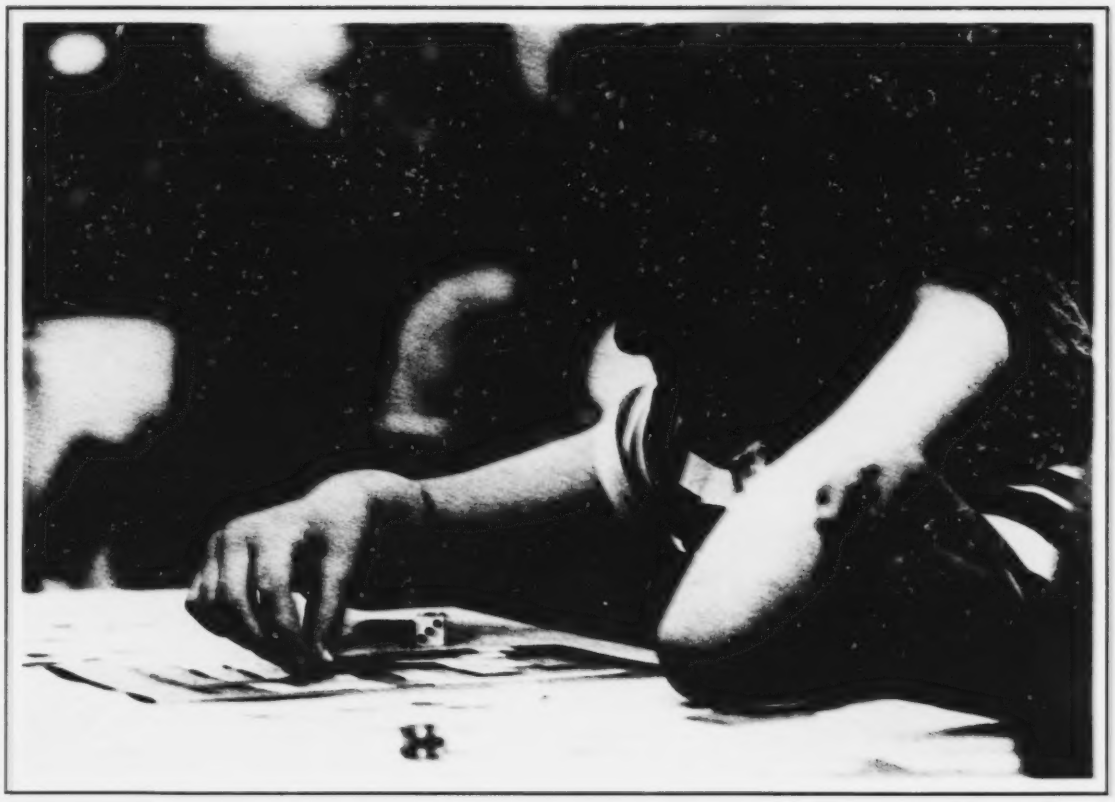

gameboard it must be placed onto the player's gameboard. If a piece taken from an opposing player's gameboard is discovered to be of no use to the player who selected it, the piece must be returned to the opposing player's gameboard and placed in its prior position and no further polyonimo may be selected for that part of a player's turn. If a player finds that a piece selected from the bank is not usable, it is returned to the bank and no other polyomino may be selected for that part of a player's turn. A player may complete the selection and placement of a second polyomino according to the dice value, even though an error was made in selecting the other polyomino as described above.

6. **A Piece Laid is a Piece Played:** Once a player is no longer touching a piece placed onto a gameboard, it may not be moved to another location.
7. **Choice of Selection:** After tossing the dice, a player can choose to take both, one, or neither of the designated polyominoes.
8. **End of Turn:** When a player has completed a turn the dice are picked up and handed to the opposing player.

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Releasing hold of the dice signals the end of a player's turn.

9. **Beginning a Turn:** Receiving the dice signals the beginning of a player's turn.

10. **Removing Polyominoes from Gameboard:** One or more polyominoes can be removed from a player's gameboard before a player tosses the dice. The decision to remove pieces is made on the basis of remaining available pieces and a player's remaining uncovered space on the gameboard. The decision to remove pieces must be carried out at the beginning of a player's turn before the dice are tossed.

11. **Win:** To win, a player must be the first to completely cover a gameboard with polyominoes so that pieces do not overlap and no two polyominoes of the same color and area are touching either edge-to-edge or corner-to-corner.

**TOURNAMENT RULES:**

12. **Challenges:** If a player violates any of the preceding rules, the opposing player may issue a challenge (during the player's turn) and before taking the dice to begin a turn. Inappropriate selection of polyominoes with regard to the dice values must be challenged within a player's turn. Inappropriate placement of a piece according to rule 3 must be challenged after the player has positioned the piece and is no longer touching the piece. If a player sees a placement error before releasing hold of the piece, the player may reposition the piece or return it as described in rule 5. A player who has not been challenged may remove inappropriately placed pieces on subsequent turns (see rule 10). To indicate that a challenge is being made a player must announce "challenge." A Mathematics Pentathlon® official must rule on this challenge. In order to do so an official time out will be granted and the official will ask the challenger to state the nature of the challenge. The official must rule on whether the challenge, as stated by the player, is correct or incorrect. If the challenge is found to be correct, the gameboards will be restored to where all polyominoes were positioned at the beginning of the challenged player's turn and the challenger will begin a turn. If the challenge is found to be incorrect, the challenger will forfeit a turn. If a player declares a "win" but has violated rule 3, the opposing player can challenge the declared "win." If so challenged, a player must remove the touching pieces and the challenger takes a turn. If a declared win which violates rule 3 is left unchallenged, an official win will be granted.



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13. **One Minute Time Limit:** Each Mathlete™ must complete a turn within one minute. If a player fails to complete a turn within one minute, a Mathematics Pentathlon® official will restore the gameboards to where all polyominoes were positioned at the beginning of that turn and the player forfeits that turn. The third violation of this rule results in forfeiture of the game. Players may not challenge each other over this rule at the Mathematics Pentathlon. An official at the tournament will decide whether or not this rule is being violated.

14. **Game Time Limit:** At the Mathematics Pentathlon, if forty-five (45) minutes of game time has run out before either player has ended the game, a win or tie will be determined on the following basis. The official will allow the second player (the player who did not begin the game) to complete a turn. After a round has been completed in this way, the Pentathlon official will remove all pieces from players' gameboards that violate rule 3 and then determine the number of empty spaces on each player's gameboard. The player with the fewer empty spaces is declared the winner. If both players have the same number of empty spaces, a tie will be declared.

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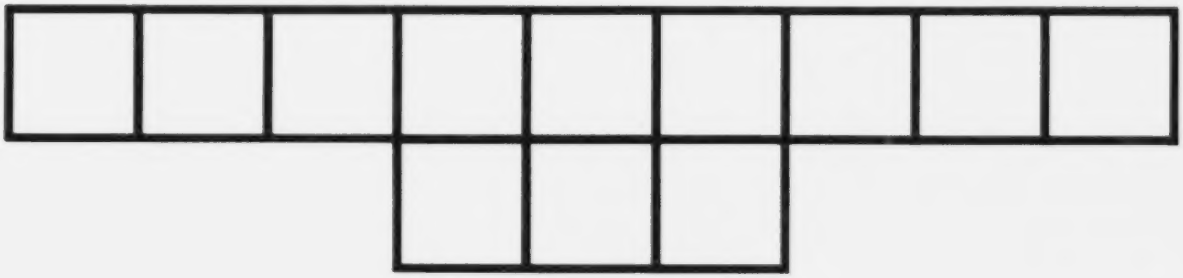
# GAMEPIECES FOR JUGGLE

## DUPLICATE THIS PAGE

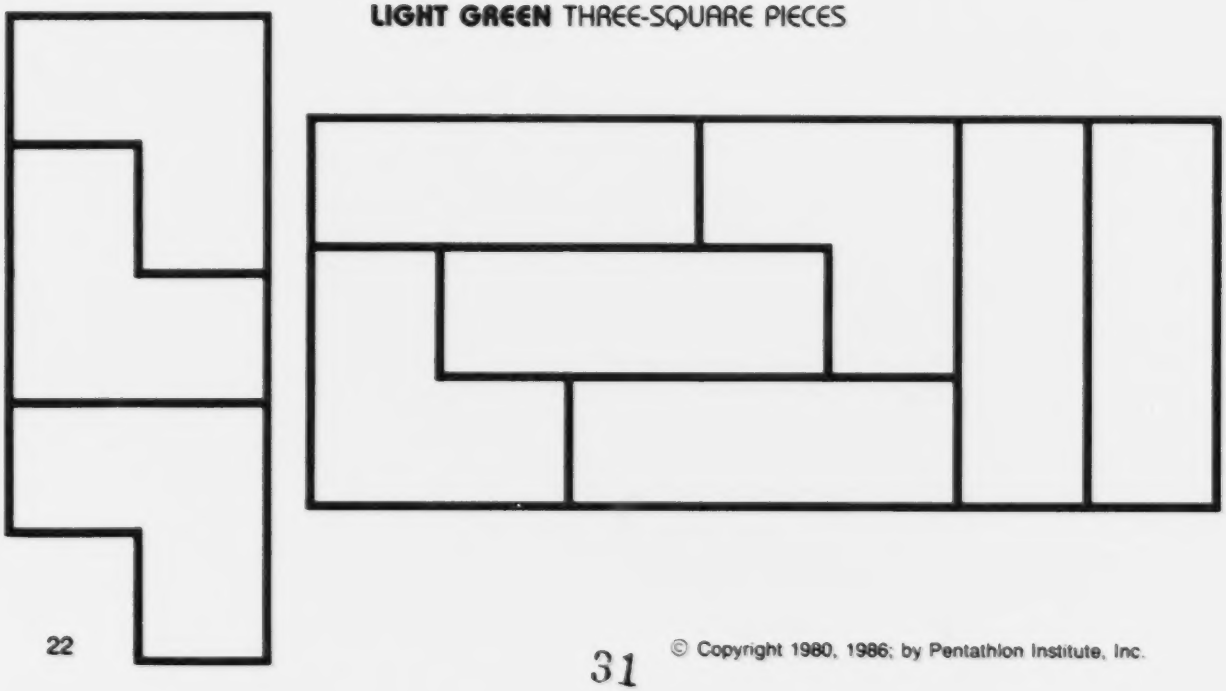
**Please color the pieces as indicated.**

**WHITE** ONE-SQUARE PIECES



**RED** TWO-SQUARE PIECES

**LIGHT GREEN** THREE-SQUARE PIECES







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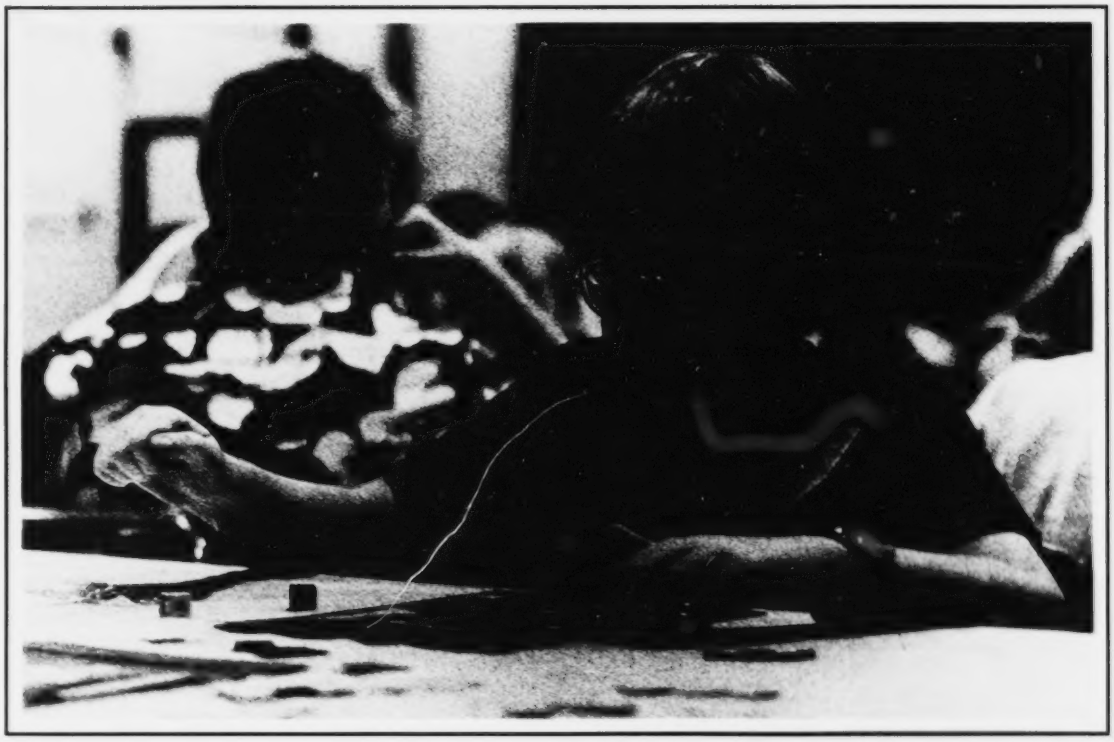

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# GAMEPIECES FOR JUGGLE

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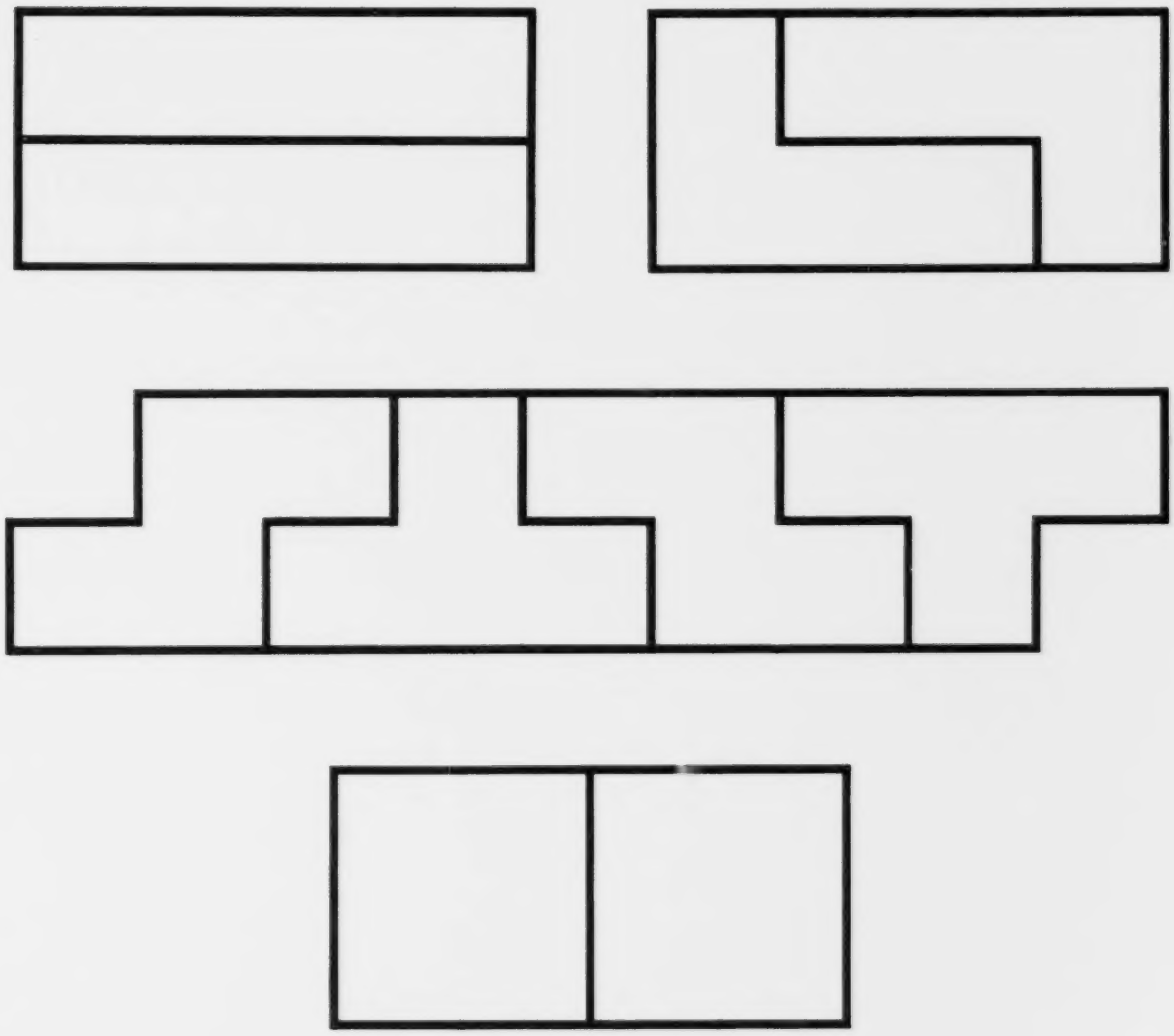
**Please color the pieces as indicated.**

**PURPLE** FOUR-SQUARE PIECES





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# GAMEPIECES FOR JUGGLE

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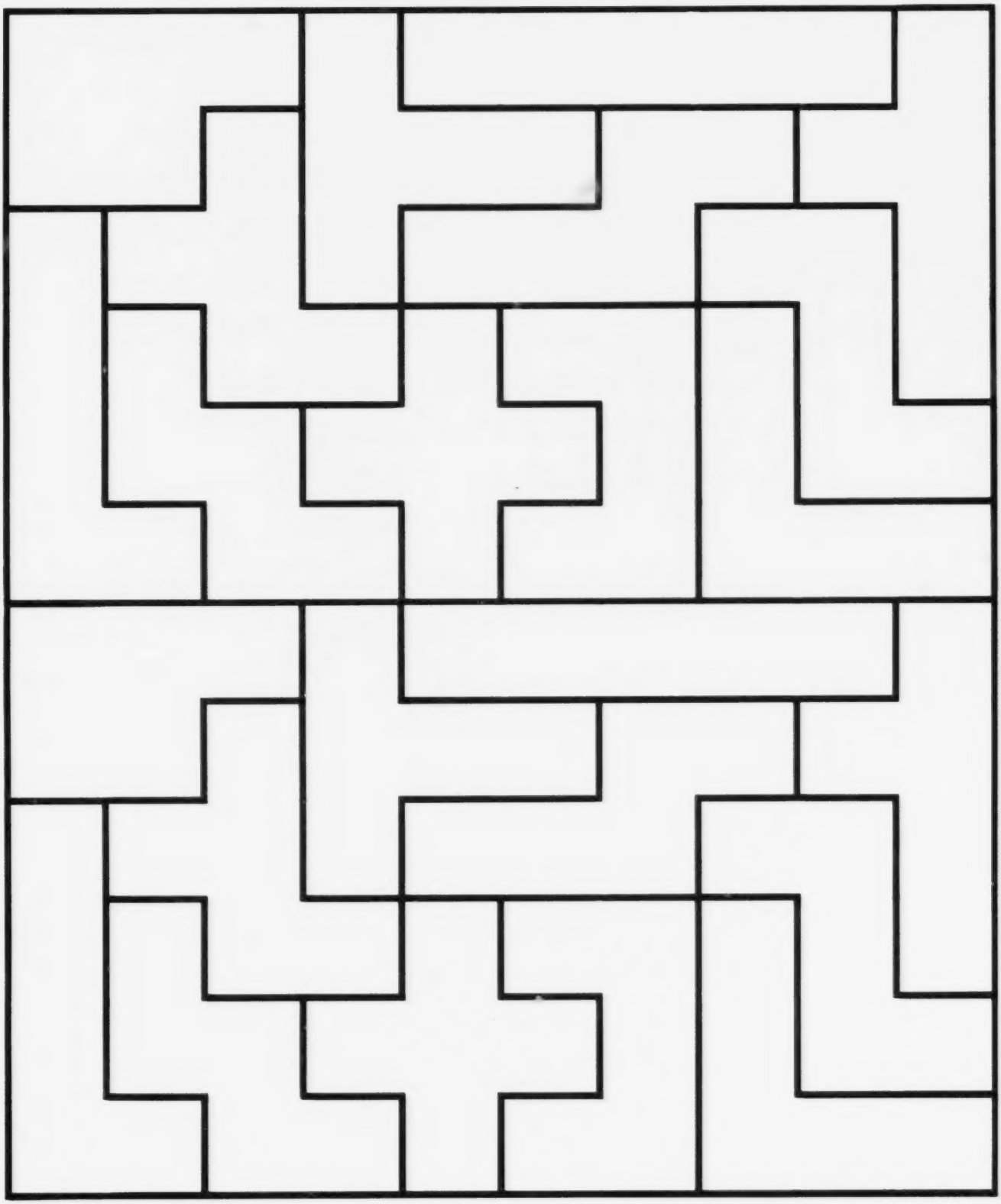
**YELLOW** FIVE-SQUARE PIECES





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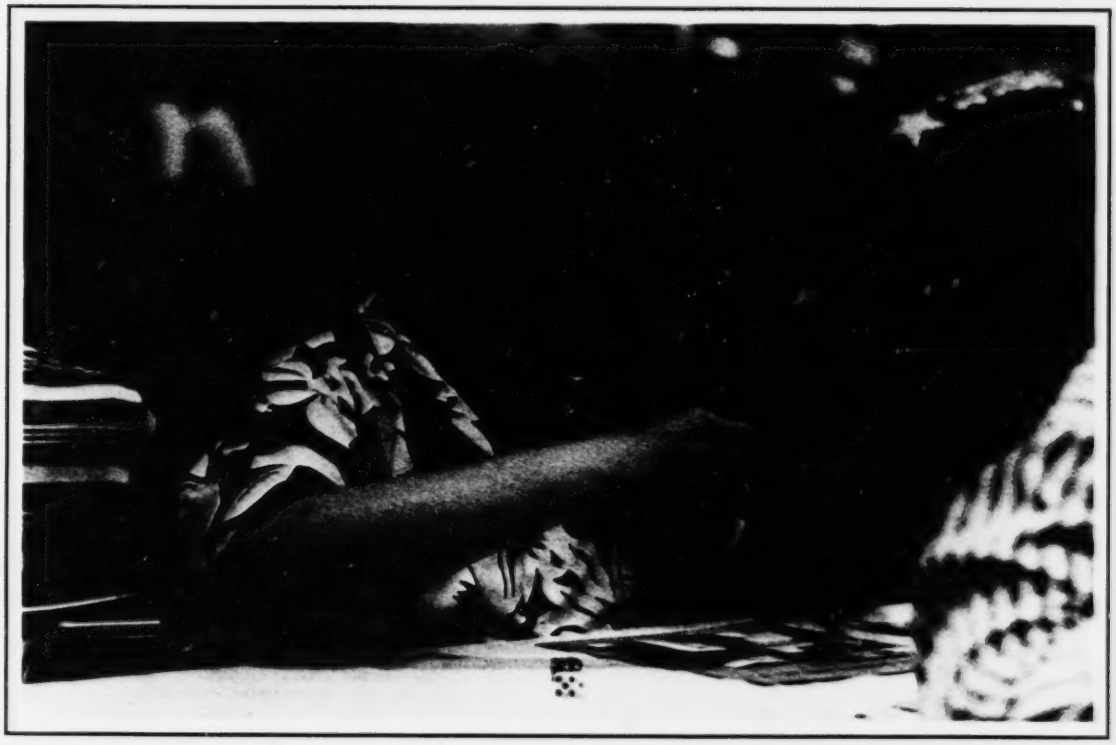

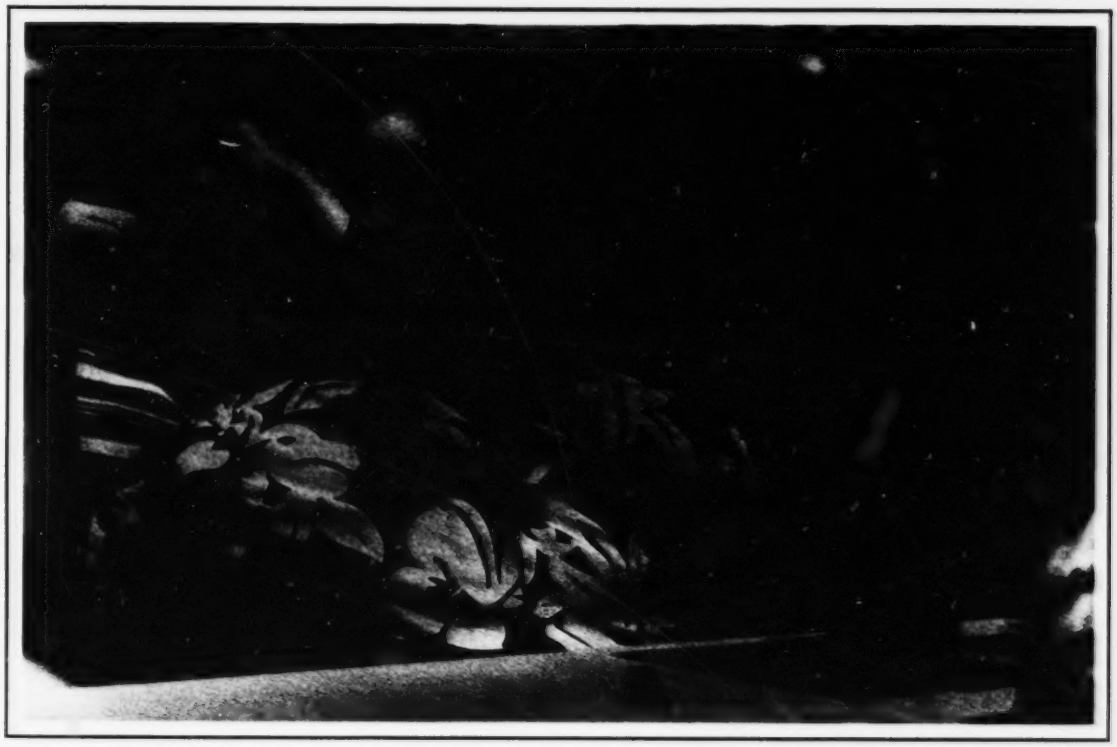

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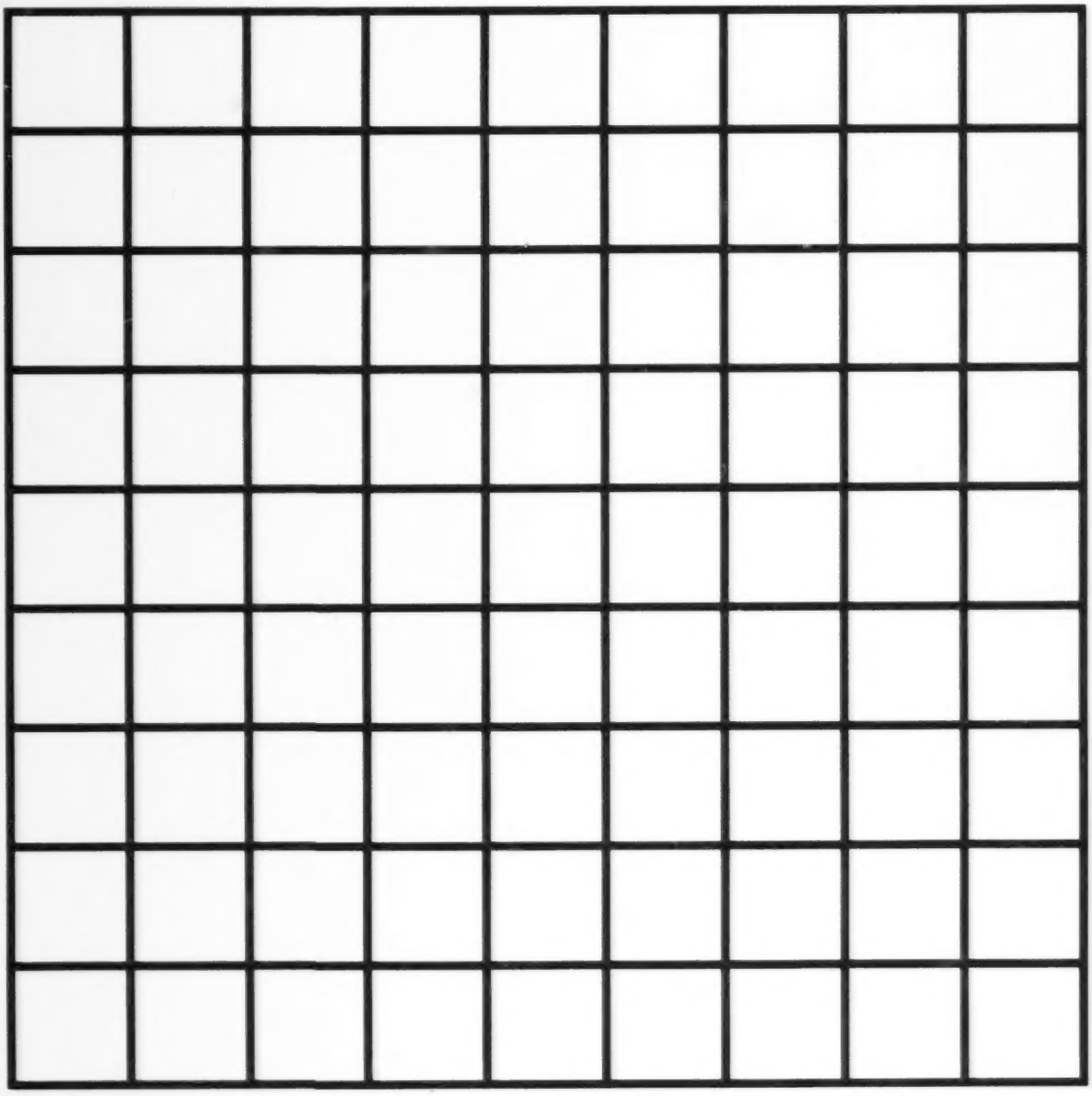
# JUGGLE



PLAYER 1

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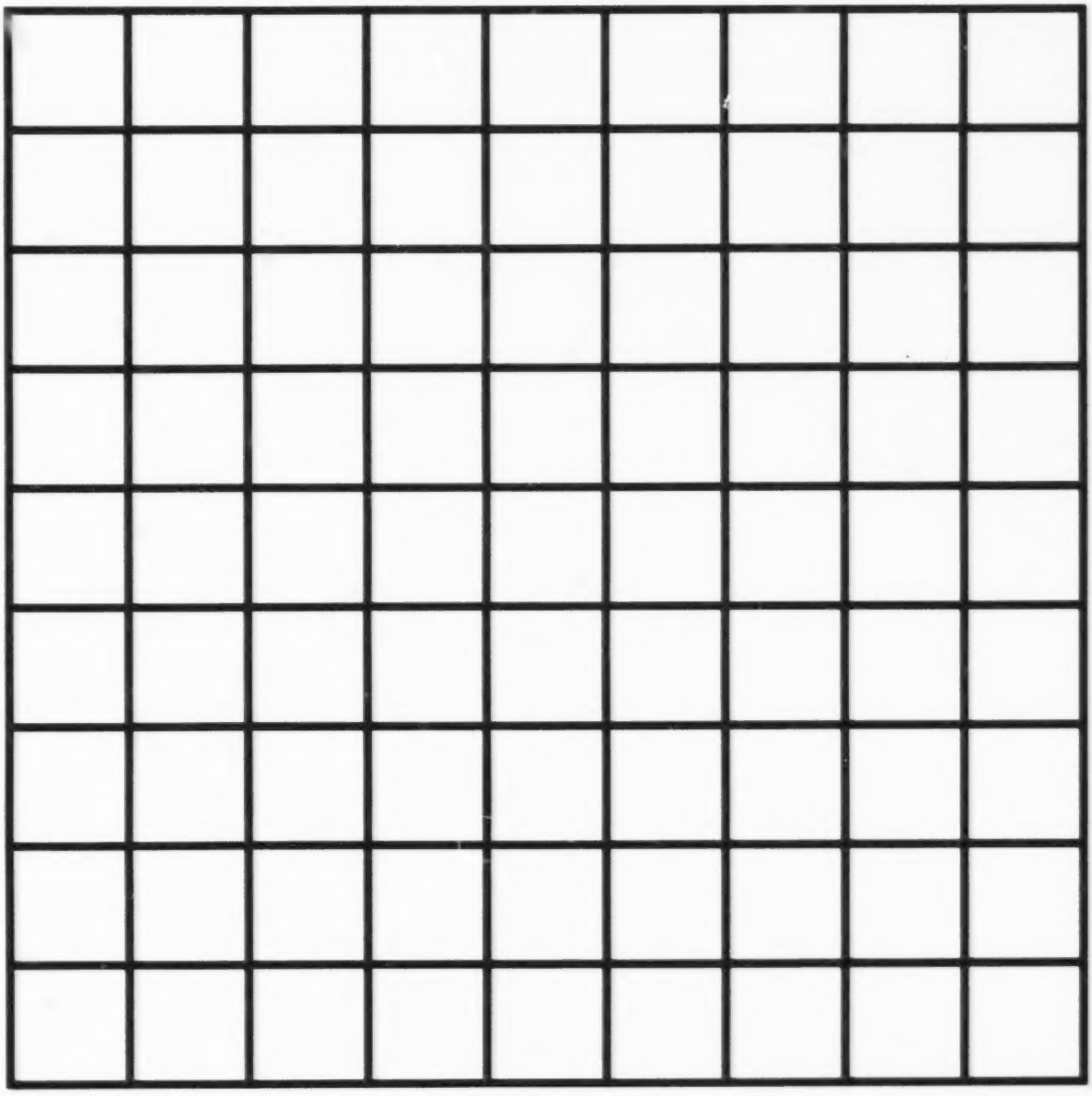
# JUGGLE



PLAYER 2

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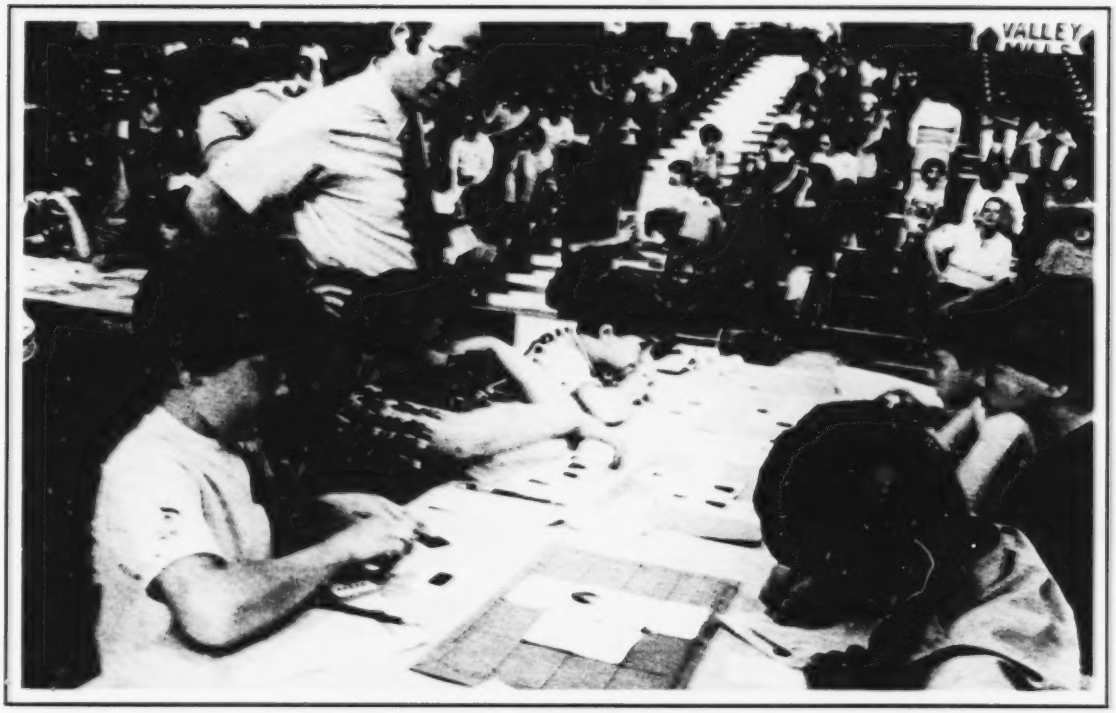


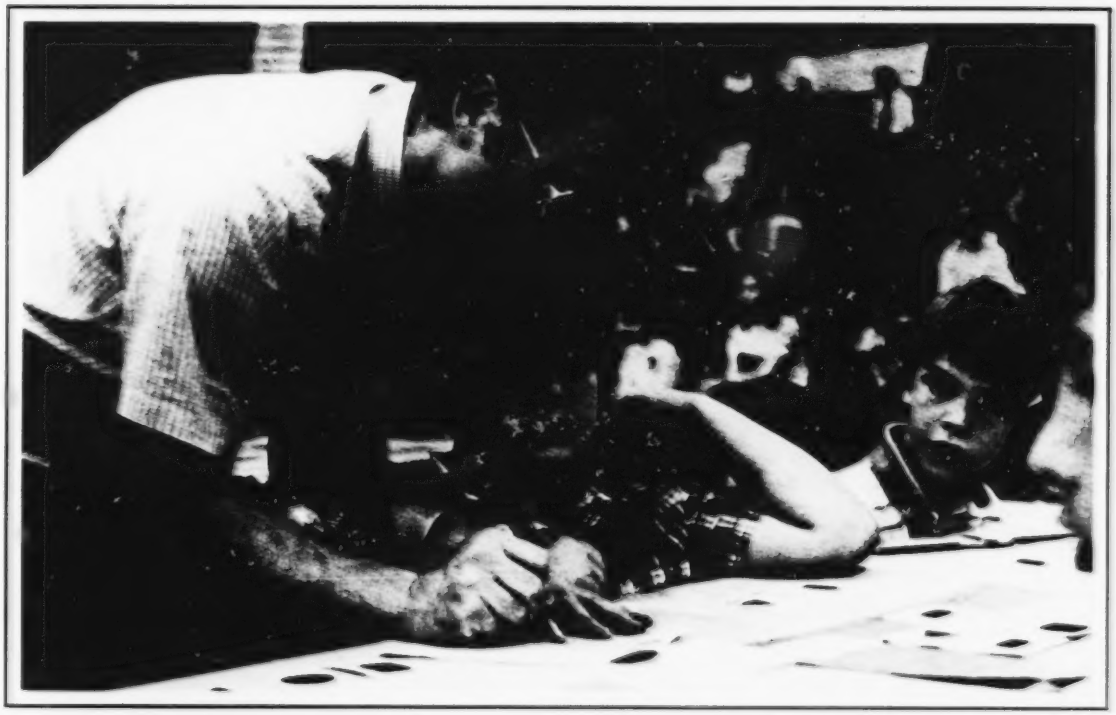



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# STARS & BARS™

**Created by**
**Dr. John C. del Regato**

This Mathematics Pentathlon® event calls for the identification of attribute differences in a multiple classification logic game for two. The sixty specially designed cards used in this game contain pictures which differ in four characteristics — shape, color, bars, and stars. A Mathlete™ attempts to place these cards onto a gameboard in such a way that the differences by one, two, three, and/or four attributes, compared to other cards already on the gameboard, are taken into consideration. Each of the sixty cards used in this event is unique and contributes to the logical networking and interrelationships formed by the gameboard's structure.

**UNDERLYING MATHEMATICS/SCIENCE:** Multiple classification, structural relationships, sorting, comparing; observation skills, experimentation, deductive and inductive reasoning

**MATERIALS:** Official Mathematics Pentathlon gameboard, Stars & Bars™ playing cards, and paper and pencil for each player

**TIME:** Total tournament playing time is forty-five (45) minutes. Each Mathlete has one minute to complete a turn. Prior to the tournament, when first learning the game, a player should be allowed more time to complete a turn.

**GOAL:** To win, a player must be the only one to acquire over 200 points at the end of a round, be 50 points ahead of the opponent at the end of a round, or have the larger number of points at the end of the game. A tie is declared if both players have the same number of points at the end of a game or both players score over 200 points at the end of a round.

**TO START:**

A. The deck of Stars & Bars cards is shuffled and placed face down between the players.

B. Players alternate drawing one card from the top of the deck. The first player to draw a starred card is the beginning player. The first four cards drawn in such a way are placed face up onto one of the central framed rectangular regions of the gameboard.

C. The players continue to alternate in drawing cards from the top of the deck until each player has a total of four cards. These cards are placed face up in front of each player. If neither player draws a starred card in this process, the beginning player is determined by the higher value toss of a die.

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D. One of the four cards belonging to the beginning player is selected by that player and is placed face up onto the gameboard according to rules 2, 4 and 5.

**RULES:**

1. **Alternating Turns:** Players alternate placing one card at a time onto the gameboard and taking one card from the top of the deck to replenish their set of four cards. Each player maintains a set of four cards until the deck is depleted.

2. **Card Placement:** Cards may be placed onto open rectangular spaces or onto another card or stacks of cards that are in a face up position on the gameboard. A player must place a card onto the gameboard even in the unlikely event that no points are gained by such placement (see rule 3).

3. **Scoring Points:** Points are made by totaling the number of differences between the card placed and the cards located in the rectangular regions surrounding (contiguous to) the rectangle where the card is placed. Points are gained according to the following criteria:

   4 points — vertical comparison, 4 ways different
   3 points — diagonal comparison, 3 ways different
   2 points — horizontal comparison, 2 ways different
   1 point — stacking comparison, 1 way different


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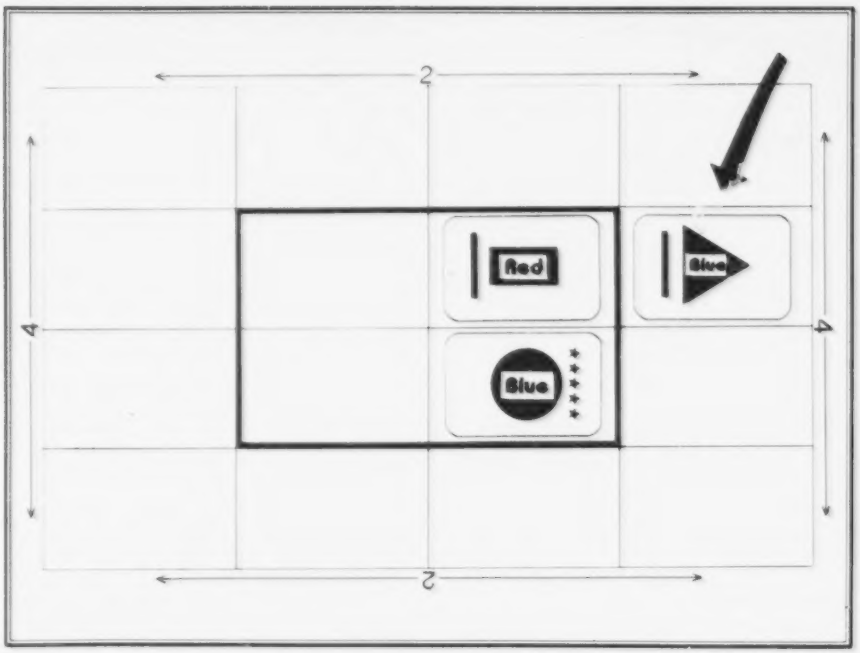
For example, if a card is placed outside of the framed central region so that it differs in exactly two ways horizontally from one card and three ways from another card which is diagonally adjacent to it, the player would score a total of five points for the play.

4. **Outside Placement:** A card placed outside of the thick lined central rectangular region *must* be placed so that in comparing it to other cards on the board it differs vertically in **exactly** four ways, horizontally in **exactly** two ways, diagonally in **exactly** three ways, and when placed on top of another card it differs from that card in **exactly** one way only.




5. **Inside Placement:** Cards placed inside the central framed area *do not have to* differ from the surrounding cards occupying adjacent spaces as described in rules 3 and 4. To the degree that they do differ as described above, points are gained. For example, a player may place a card on top of another card in the central framed area even though the cards do not differ in only one way. Suppose also, that the card vertically adjacent to the placed card does not differ in exactly four ways. But, the card diagonally adjacent does differ in three ways and another card horizontally adjacent does differ in two ways. The player would score five points for this play. (See illustration on following page.)

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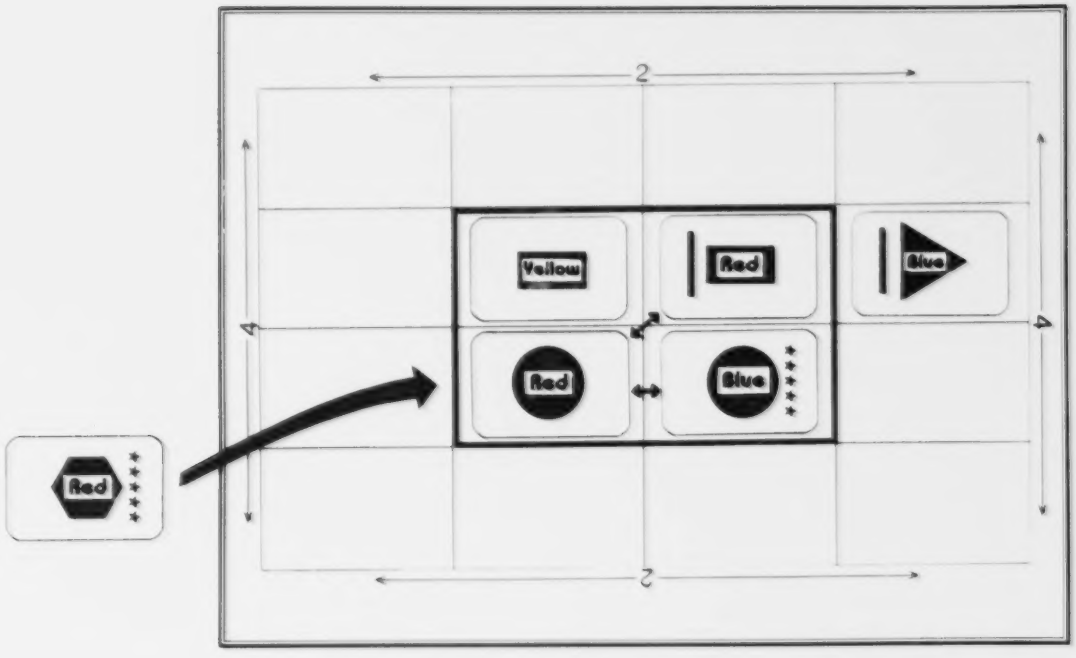


6. **Announcing Points:** Each Mathlete™ must state the total number of points gained during a turn and the accumulated total number of points *before* ending a turn (see rule 16).

7. **Recording Scores:** Each Mathlete should maintain a written record of the scores of both players. A player who has inaccurately announced a score for a turn or an accummulated score can be challenged (see rule 22). Maintaining an accurate written record may be helpful to a player if a challenge is made.

8. **Outside Four Card Stack:** Stacks of four cards in spaces outside the central framed area are to be removed from the gameboard by the player who placed the fourth card onto the stack. These cards are placed into a discard pile. A challenge (see rule 22) for failure to remove a four card stack results in having the four card stack removed, subtracting any points gained by the player in that turn, and subtracting an additional four (4) points as a penalty for not properly clearing the stack.

9. **Inside Four Card Stack:** When a stack in the central framed area contains four cards, it is to be turned over and placed face down on the gameboard. This is to be done by the player who has contributed the fourth card to the stack. A challenge (see rule 22) for failure to turn


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over a four card stack results in having the stack turned over, subtracting any points gained by the player within that turn, and subtracting an additional four (4) points as a penalty for not properly turning over the stack.

10. **No Five or More Card Stack:** Within any turn, when a player does not challenge an opponent for failing to remove a four or more card stack, the result is that the four or more card stack remains face up on the board. If a player risks adding an additional card to the stack and is challenged, the stack is removed, any points gained by the player in that turn are subtracted, and an additional five (5) points as a penalty will be subtracted.

11. **No Turn Over of a Three or Less Card Stack:** Should a player turn over stacks of 3 or less cards the opponent may challenge. This challenge results in the stack being turned up into a face up position, any points gained by the player in that turn are subtracted, and an additional five (5) points as a penalty will be subtracted.

12. **Clearing the Central Framed Area:** When card stacks in the central framed area are turned over they are no longer used for difference comparison. When all four rectangular spaces in the central framed area contain stacks of overturned cards, all of these stacks are removed from the gameboard and placed into a discard pile. The player-

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who completes the fourth stack is responsible for clearing the central framed area of the gameboard of the four stacks. A challenge (see rule 22) for failing to properly clear the central area under these conditions results in the cards being removed from the central framed area, any points gained during that turn being deducted from the player's score, and a penalty of sixteen (16) points being subtracted from the player's score. The same penalty would result if a player were to be challenged at some point in the game for adding a card to a fourth stack of four cards all located within the central framed area.

13. **Face Down — No Cards:** No cards can be placed onto a stack of cards which has been turned over.
14. **Depleted Deck:** When the deck of Stars & Bars™ cards has been depleted, players continue to place their cards onto the gameboard. At this point in the game, the completion of a turn is signaled by tapping the selected card after placing it onto the gameboard.
15. **Beginning a Turn:** A player's turn begins when an opponent has drawn a card from the deck of Stars & Bars cards. When the deck of Stars & Bars cards has been depleted a player's turn begins when an opponent has signaled a completion of turn by tapping the last card placed onto the gameboard.
16. **End of Turn:** A player's turn ends when a card is drawn from the deck of Stars & Bars cards. When the deck of Stars & Bars cards has been depleted a player's turn ends when the player has tapped the last card placed onto the gameboard.
17. **A Round:** A round consists of the beginning player and second player completing a turn.
18. **Change Selected Card:** A player may change a selected card even after placing it onto the gameboard. This must be done prior to ending a turn, (see rule 16).
19. **End of Game:** The game has ended when both players have no more cards to place onto the board. Or, if a player has won or players have tied according to the conditions stated in rules 20 and 21.
20. **Win:** If only one player has over 200 points at the end of a round or has 50 more points over an opponent at the end of a round, a win has been accomplished. Winning in either of these two ways must be announced by the winning player saying "Stars & Bars." The player with the most points at the end of game is declared the winner.


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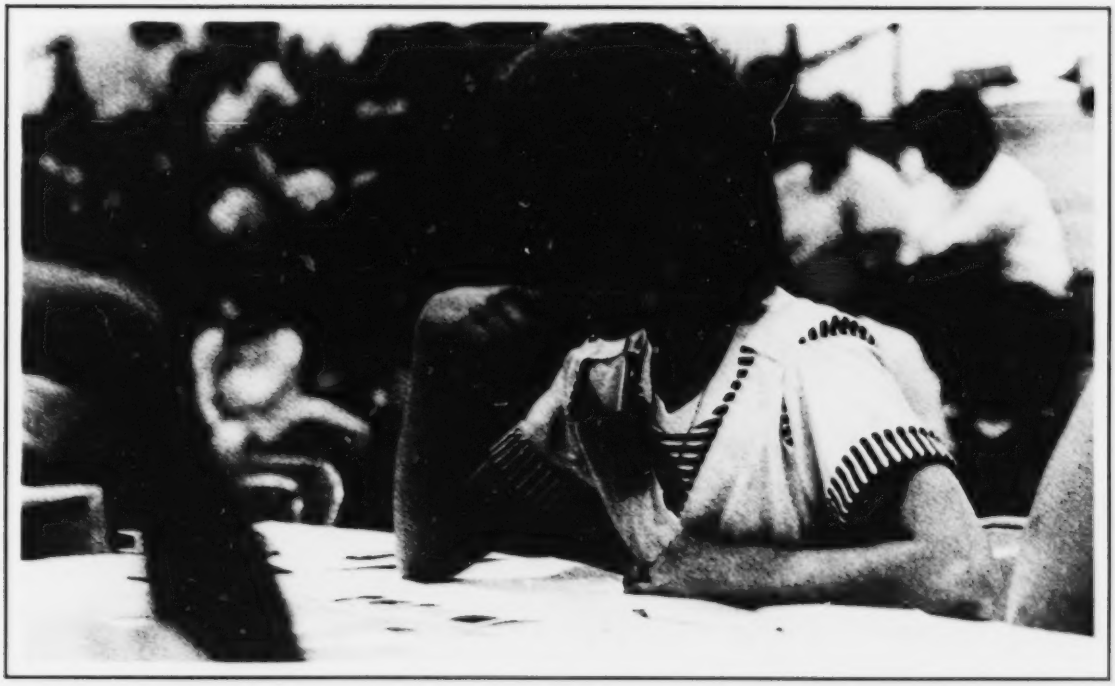

21. **Tie:** If both players score over 200 points at the end of a round, a tie is declared. Both players do not need to have the same identical score for a tie to be declared under this rule. If both players have the same identical score at the end of the game, a tie is declared.

**TOURNAMENT RULES:**

22. **Challenges:** If a player violates any of the preceding rules, the opposing player may issue a challenge after a player has ended a turn. To indicate that a challenge is being made, a player must announce "challenge." A Mathematics Pentathlon® official must rule on this challenge. In order to do so, an official time out will be granted and the official will ask the challenger to state the nature of the challenge. The official must rule on whether the challenge, *as stated by the player*, is correct or incorrect. If the challenge is found to be correct, points claimed for that turn are subtracted from the challenged player's score. Rules eight (8) through twelve (12) describe additional penalties incurred for their violation. The violation of other rules when challenged would result in a penalty of two (2) points. This would be deducted from the challenged player's score. Cards placed onto the gameboard are left where they were placed and the card drawn from the deck is retained by the challenged player. If the challenge is found to be incorrect, the challenger is penalized two (2) points and forfeits a turn.

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23. **One Minute Time Limit:** Each player must complete a turn within one minute. If a player fails to complete a turn within one minute, a Mathematics Pentathlon® official will restore the gameboard to where all cards were at the beginning of that turn and the player forfeits that turn. The third violation of this rule results in forfeiture of the game. Mathletes™ may not challenge each other over this rule at the Mathematics Pentathlon. An official at the tournament will decide whether or not this rule is being violated.

24. **Game Time Limit:** At the Mathematics Pentathlon, if forty-five (45) minutes of game time has run out before either player has ended the game, a tie or win will be declared under the following procedure. The official will allow a round to be completed. After completing a round if none of the preceding rules applies in identifying a winner, and if one player is fifteen (15) or more points over the opponent's score, a win will be declared. If this does not occur, a tie will be declared.

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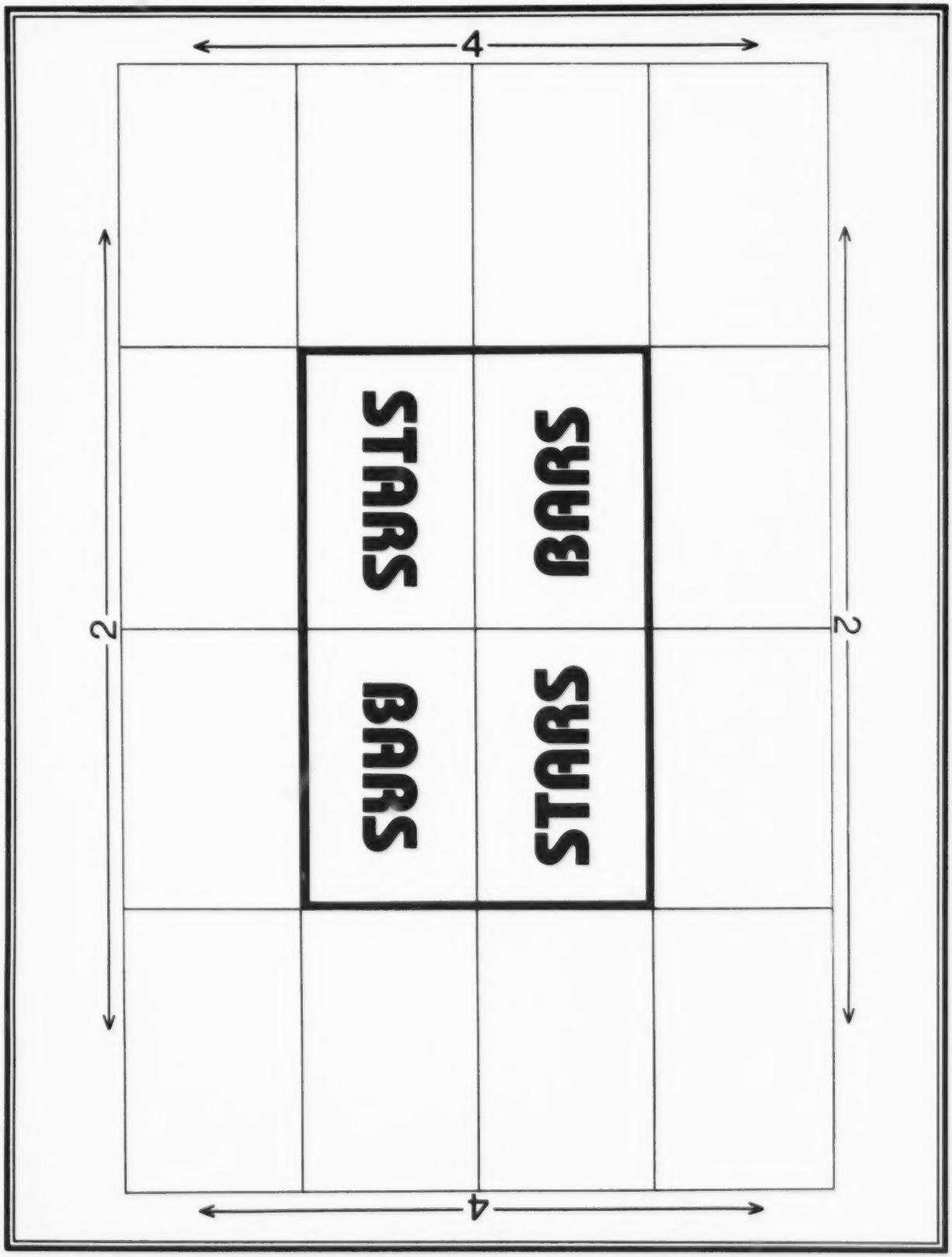


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# QUEEN'S GUARD™

**Created by**
**Dr. John C. del Regato**

This Mathematics Pentathlon® event is a major revision of a popular board game played during the Victorian Era. Invented around 1890, the original game was known as Agon. The original name may have been given because of the agonistic behavior of bees in a beehive simulated by the aggressive, defensive, and avoidance strategies used in the game. The approach-avoidance or agonistic behavior is seen in this game as each player attempts to regulate the spatial distribution of the opposing player's pieces while simultaneously seeking to control the center of the gameboard. Agon also is a term referring to a contest between two people and indeed this tournament version offers a two-person contest which combines the complexity of the strategy in Chess with the simplicity of the moves in Checkers. The specially designed gameboard used in this event provides a tessellated region of ninety-one hexagons. There is an outer band of thirty hexagons, then twenty-four, eighteen, twelve, six, and in the center a single hexagon known as the throne. These concentric bands alternate from starred to blank rings. A set of playing pieces consisting of a Queen and six Guards is provided for both players. Each Mathlete™ attempts to position the Queen in the throne and to surround the throne with the Queen's six Guards. A novice at this game may at first feel spatially disoriented by the non-rectangular aspects of the gameboard. A Mathlete who has learned to correct for the visual misinterpretations that might have been experienced will, with repeated exposure to this game, develop a dynamic spatial reasoning.

**UNDERLYING MATHEMATICS/SCIENCE:** Spatial reasoning, symmetry; observational skills, hypothesizing and experimentation, deductive and inductive reasoning

**MATERIALS:** Official Mathematics Pentathlon gameboard, two sets of seven pieces — each set a different color and consisting of one "Queen" and six "Guards"

**TIME:** Total tournament playing time is forty-five (45) minutes. Each Mathlete has one minute to complete a turn. When a player is first learning the game, more time should be allowed.

**GOAL:** To win, a player must be the first to position the Queen on the center hexagon and have it completely surrounded by the players six Guards. The six Guards must be positioned on the six hexagonal spaces surrounding the center space. A tie will occur if one player's six Guards are placed onto these six hexagonal spaces without the Queen occupying the center space (see illustration on following page). A tie also occurs when a player cannot move without violating one of the game rules.

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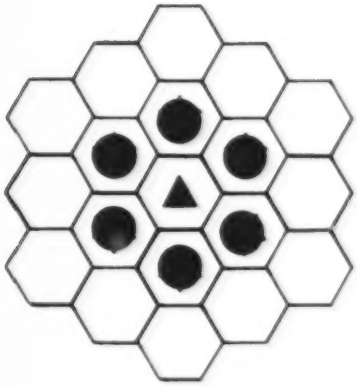
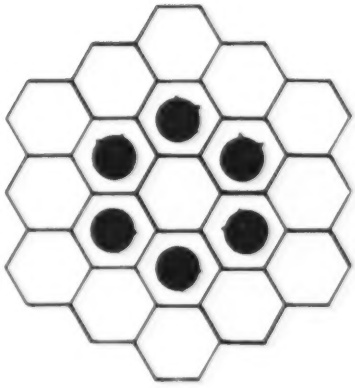


Won Game



Tie Game

**TO START:**

A. Players place their pieces onto the gameboard in their starting positions. Hexagonal spaces marked with triangles are the starting positions for one player's pieces. The triangle with crossing lines marks the starting position for a Queen. This space can be found at one end of the gameboard. The remaining spaces marked with triangles are the starting positions for the six Guards. The space marked with a square containing crossed lines is for the opposing player's Queen. This space can be found at the opposite end of the gameboard. All other hexagonal spaces marked with squares identity the starting positions for the opposing player's Guards.

B. A color is chosen as the starting color by one of the players. The opposing player picks up both Queens and places one in each hand, out of view of the other player. The other player selects a hand and takes that Queen. If the Queen is of the starting color the player will begin the game, if not, the opposing player will begin the game.

C. Queens are placed onto their starting positions along with the Guards. The pieces should be placed onto the gameboard so that the Queen is positioned nearest the player to whom it belongs.

**RULES:**

1. **Alternating Turns:** Players alternate taking turns. Each player moves one piece in any given turn. The player with the starting color begins.

2. **Queen & Guard Movement:** A piece may move only one space within a turn into a vacant adjoining hexagon. A Queen or Guard may be moved to one hexagon on the same band (either starred or blank) or to an adjoining hexagon of the next inner band toward the center of the gameboard (see illustration on following page). Unless trapped (see rules 5 through 11) a piece may not move away from the center of the board. This means that a



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piece may not move from a hexagon of one band to a hexagon within the next outer band.

3. **Queen's Start and Throne:** Only a Queen may be placed onto the center hexagon. The starting positions for each Queen can only be occupied by the Queen assigned to that space at the beginning of the game. One Queen cannot occupy another Queen's starting position at any time within the game. Guards may not be placed into either the starting positions for the Queen or the center hexagon.
4. **Touch-Move:** Once a player's piece has been touched by the player, it must be moved to complete a turn.
5. **Trap:** A Queen or Guard is trapped when it lies between two opposing pieces along a straight lined path of three adjoining hexagons. The three pieces involved can, but do not need to, all lie in the same type (starred or blank) band. The opposing pieces forming the trap may be two Guards or a Queen and a Guard (see illustration below).

6. **Moving a Trapped Piece:** A trapped Guard must be moved if possible (see rule 11) to an adjacent hexagon space within the next outer concentric band. A trapped Queen must be moved back to its start position. A trapped piece may not be moved into an adjacent hexa-

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gon space within the same band or within the next inner concentric band toward the center. A trapped piece is to be moved by the trapped player. In moving out of a trap a player may be forced to move the trapped piece into another trap. Rule 10 may then be exercised by the opponent.

7. **Moving a Nontrapped Piece While Trapped:** When trapped, a player might attempt to move some other nontrapped piece. If challenged for this, the player will have to return the piece which was illegally moved to the position it was in at the beginning of that turn and the player forfeits the turn.
8. **Announcing a Trap:** A player may or may not choose to announce that an opponent's piece is trapped. Whether or not a trap has been announced, a player may still challenge an illegal move.
9. **Multiple Traps:** If a Queen and a Guard are trapped simultaneously, the Queen must be moved back to its starting location first. If the Guard remains trapped on the following turn, it must be moved back to an adjacent hexagon space within the next outer concentric band.

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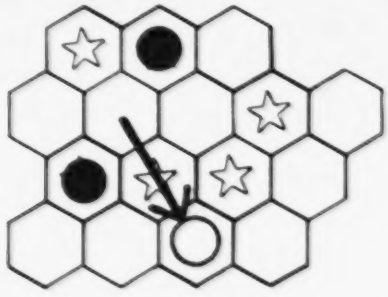
If more than one Guard is trapped, the trapped player is free to choose which Guard will be the first to be moved out of the trapped position. On the following turn if the remaining Guard is trapped, it must be moved into an adjacent hexagon space within the next outer concentric band.

10. **Moving Into Trap:** If a player moves either a Queen or Guard into a trapped position, the opposing player may on the next turn pick up the trapped piece and place it onto a hexagon space within the outermost band. The opposing player then completes a turn. If the opposing player does not exercise this option during the following turn, the trapped piece is subject to rule 6.



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11. **A Blocked Trap:** When trapped, if a Guard cannot be moved into an adjacent space within the next outer concentric band, because all such spaces are occupied by other pieces or the trap occurs on the outermost band, a player may ignore the trapped situation(s) and move another piece. If the pieces blocking the trap are moved out of the way during the game and the piece is still trapped, it is subject to rule 6.
12. **Beginning A Turn:** A player's turn begins after an opponent has moved a piece to a new location on the gameboard and released touch from the piece.
13. **End of Turn:** A player's turn ends when the player has moved a piece to a new location on the gameboard and released touch from the piece.
14. **Win:** To win, a player must position the player's Queen in the center of the gameboard and position all six of the player's Guards onto the six hexagon spaces surrounding the center space.
15. **Tie:** A tie occurs when a player is not able to move without violating one of the rules. A tie also occurs if all of a player's six Guards are positioned around an unoccupied center space.

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**TOURNAMENT RULES:**

16. **Challenges:** If a player violates any of the preceding rules, the opposing player may issue a challenge at the end of the player's turn and before touching a piece. To indicate that a challenge is being made, a player must announce "challenge." A Mathematics Pentathlon® official must rule on this challenge. In order to do so, an official time out will be granted and the official will ask the challenger to state the nature of the challenge. The official must rule on whether the challenge, as stated by the player, is correct or incorrect. If the challenge is found to be correct, the gameboard will be restored to where the Queens and Guards were positioned at the beginning of the challenged player's turn and the challenger will begin a turn. If the challenge is found to be incorrect, the challenger will forfeit a turn. If a player issues three consecutive incorrect challenges, the challenger will forfeit the game.
17. **One Minute Time Limit:** Each Mathlete™ must complete a turn within one minute. If a player fails to complete a turn within one minute, a Mathematics Pentathlon official will restore the gameboard to where all markers were positioned at the beginning of that turn and the player

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forfeits that turn. The third violation of this rule results in forfeiture of the game. Players may not challenge each other over this rule at the Mathematics Pentathlon®. An official at the tournament will decide whether or not this rule is being violated.

18. **Game Time Limit:** At the Mathematics Pentathlon, if the forty-five (45) minutes of game time has run out before either player has accomplished a win, a tie is declared. If a player has touched a piece and is in the process of moving a Queen or Guard when game time is called, the player will be allowed to complete that turn. If game time is called and a player has not touched a Queen or Guard for movement, the game has ended and a tie is declared.

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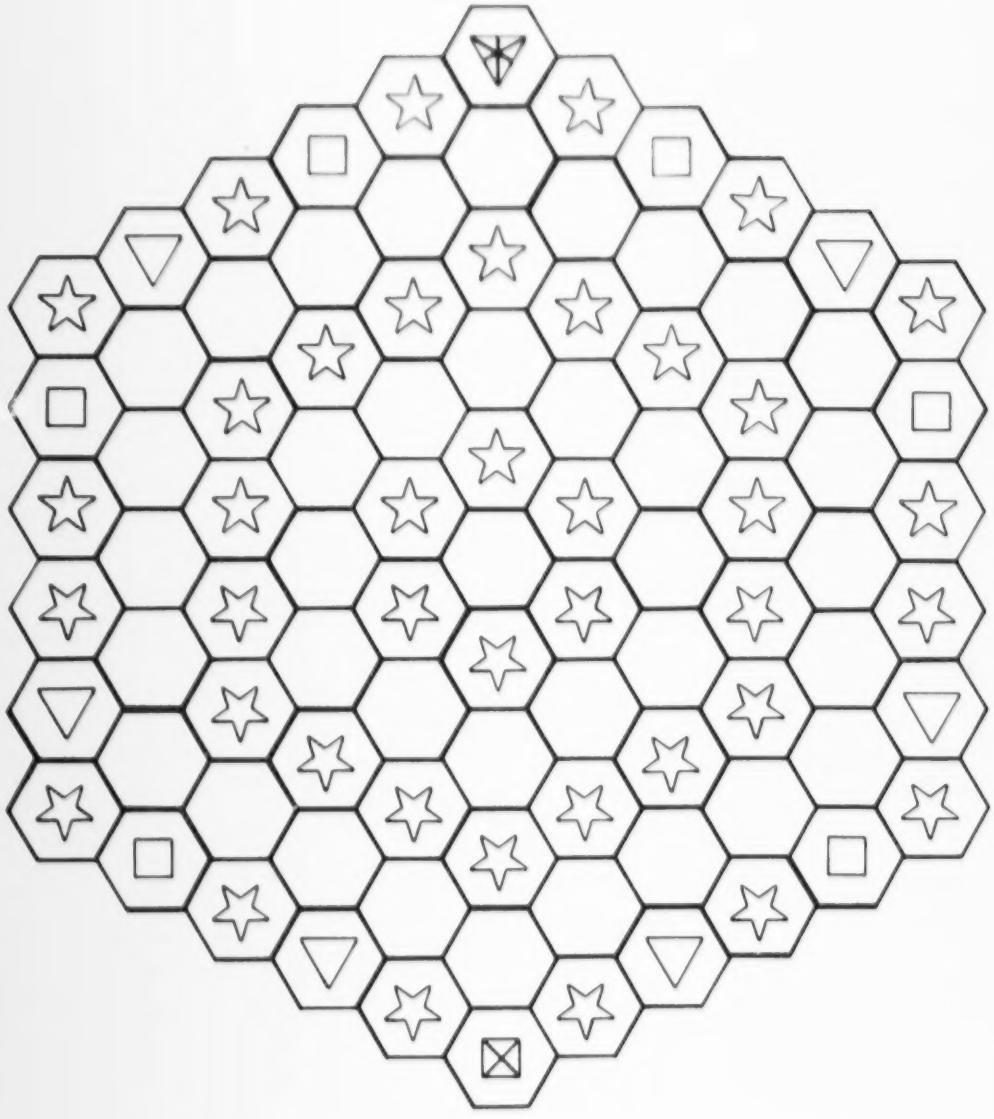
# QUEEN'S GUARD



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# FAB™

## (Fractions Adding Bars)

**Created by**
**Dr. John C. del Regato**

The ability to add fractions pictorially and state the corresponding equation constitutes the focus of this Mathematics Pentathlon® game. Mathletes™ preparing for the tournament should become thoroughly familiar with the set of 32 fraction bars which may be combined in a variety of ways to represent the addition of fractions. The concept of equivalence is also developed in experiencing this game. Although chance does enter into this event, a player will usually have many opportunities to strategically capture three-bar tricks which will not only increase the player's score but minimize an opponent's choices.

**UNDERLYING MATHEMATICS/SCIENCE:** Fraction representation, equivalence, partitioning, addition of fractions; observation skills, hypothesizing and experimentation, deductive and inductive reasoning

**MATERIALS:** Official Mathematics Pentathlon gameboard, and a set of 32 different fraction bars in five fraction coded colors

**TIME:** Total tournament playing time for a series of three games is forty-five (45) minutes. Each player has one minute to complete a turn. When a player is first learning the game, more time should be allowed.

**GOAL:** To win, a Mathlete must have the greater number of three-bar tricks in two (2) out of three (3) games or win one (1) and tie in two (2) out of a series of three (3) games.

**TO START:**

A. The fraction bars are shuffled, formed into a single stack, turned face down, and placed onto the indicated gameboard "DECK" area.

B. Each player selects a fraction bar from the draw pile ("DECK"). The player with the smaller value begins. If the first two bars drawn by the players are equivalent in value, each player selects another two for comparison. This process would continue until a beginning player is identified.

C. The beginning player reshuffles all of the fraction bars. After reforming a draw pile, the beginning player turns over the top three fraction bars and places them in the starting locations indicated by stars on the gameboard (see illustration on the following page).

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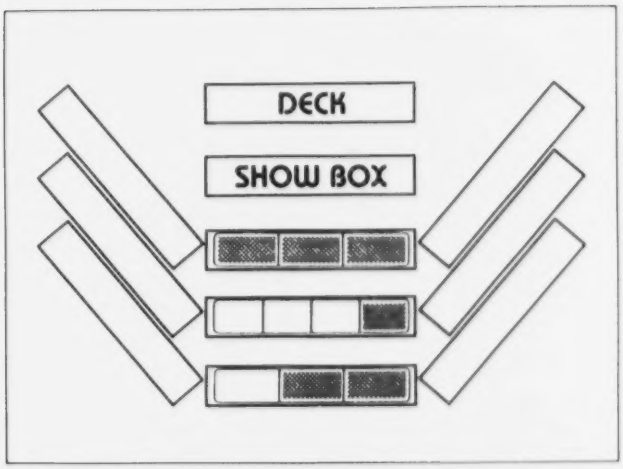


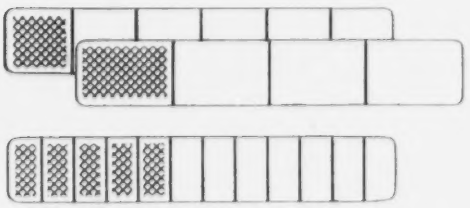

D. The beginning player selects another bar off the top of the draw pile and tries to form a trick (see rules 2 and 3).

E. Players alternate being the beginning player in the series of two (2) or three (3) games necessary to establish a win or a tie. Thus parts C and D would be repeated for a second and possibily a third game.

**RULES:**

1. **Alternating Turns:** Players alternate turns drawing one bar from the draw pile and trying to form tricks of three fraction-bars.

2. **Selecting and Searching:** Each player in turn selects the top bar from the draw pile and tries to find two bars facing up which if laid shaded-end to shaded-end would have a total shaded amount equal to the bar drawn.



$$\frac{1}{6} + \frac{1}{4} = \frac{5}{12}$$

3. **Show-Touch-Say:** The player must immediately place the drawn fraction bar into the show box on the gameboard. Before announcing a trick, the player must touch the two fraction bars on the gameboard which along with the fraction bar in the show box comprise a trick. After touching the two bars on the gameboard, the player must announce the arithmetic sentence involving the three fraction bars.

4. **Announcing a Trick:** When a player has found two bars which have a total shaded amount equal to the bar drawn, the three bars are collected together to form a



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trick. Before removing the fraction bars from the gameboard, the player must clearly announce the arithmetic sentence represented by the three fraction bars forming the trick. The exact values represented by the fraction bars or equivalent fraction expressions can be used in stating the arithmetic sentence, e.g. "1/6 + 1/4 = 5/12" (see illustration on page 52).

5. **No Trick:** If a trick cannot be made, the player moves the fraction bar from the show box onto one of the available boxes marked on the gameboard. In the event that all boxes are occupied, place additional bars in an area adjacent to the gameboard. All "no trick bars" are placed in a face-up position.

6. **Trick Placement:** The three bars forming a trick are placed face down on the right hand side of the player off the gameboard. Successive tricks are stacked in criss-cross fashion.

7. **Touch-Take:** Once a fraction bar on the gameboard has been touched (other than those in the draw pile or show box) it must be used to form a trick. If a trick is not possible with a fraction bar that has been touched, the play-

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er must move the fraction bar drawn out of the show box and place it face-up onto one of the available boxes marked on the gameboard.

8. **Zero-One:** If there are less than two fraction bars in a face-up position on the gameboard, a player's turn consists of placing a drawn fraction bar onto the gameboard. The drawn fraction bar is not placed into the show box in this case.
9. **Announcing "FAB":** A player has 10 seconds from the end of an opposing player's turn to declare "FAB" and capture a trick that was not detected by the opposing player. The arithmetic sentence for this captured trick must be clearly announced to the opposing player. After making this capture, the player has 10 seconds to pick up a bar from the draw pile to begin a regular turn.
10. **Beginning a Turn:** A player's turn begins when the opposing player has released hold of a captured trick or released hold of a fraction bar placed onto the gameboard. In the case of announcing "FAB," a player's regular turn begins after releasing hold of the captured FAB trick.
11. **End of Turn:** A player's turn ends when the player has released hold of a captured trick or released hold of a fraction bar placed face up onto the gameboard.
12. **End of Game:** Each game has ended when the draw pile is empty at the beginning of a player's turn.
13. **Win/Tie:** At the end of a game the player with the most tricks wins. If both players have the same number of tricks, a tie is declared.
14. **Winning the FAB event:** At the Mathematics Pentathlon® the Mathlete™ who wins two (2) out of three (3) games or who wins one (1) game and ties in two (2) games is the winner of the FAB event.
15. **A Tie in the FAB event:** If the Mathletes at the Pentathlon tie all three games in the series, a tie will be declared. If one Mathlete wins one game and the opposing Mathlete wins another game in the series and a third game in the series is tied, a tie will be declared for the FAB event.

**TOURNAMENT RULES:**

16. **Challenges:** If a player violates any of the preceding rules, the opposing player may issue a challenge. To indicate that a challenge is being made a player must announce "challenge." A Mathematics Pentathlon official must rule on this challenge. In order to do so, an official time out will be granted and the official will ask the challenger to


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state the nature of the challenge. The official must rule on whether the challenge, as stated by the player, is correct or incorrect. A player may be challenged for not stating an arithmetic sentence before taking a trick or for stating an incorrect arithmetic sentence. The challenger does not have to state the correct equation. (WARNING: equivalent expressions for the fraction representations can be used in stating the arithmetic sentence.) A challenger has ten (10) seconds from the end of an opposing player's turn to declare CHALLENGE and *must do so before drawing a bar from the draw pile.* A challenge to a captured "FAB" trick (see rule 9) as well as any other trick must be made during this time interval.

If a challenge is found to be correct, the three bars forming the trick or tricks are awarded to the challenger and are placed onto the challenger's stack of tricks. The challenger then begins a turn. If the challenger is found to be incorrect, the challenger forfeits that turn.

17. **One Minute Time Limit:** Each player must complete a turn within one minute. If a player fails to complete a turn within one minute, a Mathematics Pentathlon® official will restore the gameboard to where all fraction bars were

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positioned at the beginning of the turn and the player forfeits that turn. The third violation of this rule results in forfeiture of the game. Players may not challenge each other over this rule at the Mathematics Pentathlon®. An official at the tournament will decide whether or not this rule is being violated.

18. **Game Series Time Limit:** At the Mathematics Pentathlon, if the forty-five (45) minutes of game series time for this event has run out before either player has established a win, the official at the tournament will determine a win or tie on the following basis. If time is called before a Mathlete™ has completed a turn, that turn will be allowed to be completed. The tricks accumulated to that point in the game will be determined. The Mathlete holding the most tricks will be declared the winner of that game. A win or tie for the event will then be determined by rules 14 and 15. If a series of only two games are played with one player winning one game and the opposing player winning the second, a tie is declared. If a series of only two games are played with one player winning one game and a tie occurring in the second game, a win will be granted to the player who won one of the games.
19. **Calculators Prohibited:** Calculators are most important in mathematics problem solving. For tournament play, however, calculators are not permitted in FAB.
20. **Pencil and Paper Optional:** A player may use pencil and paper to record any of the announced arithmetic statements.

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# GAMEPIECES FOR FAB

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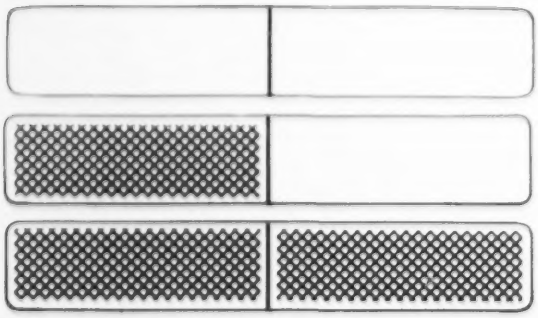
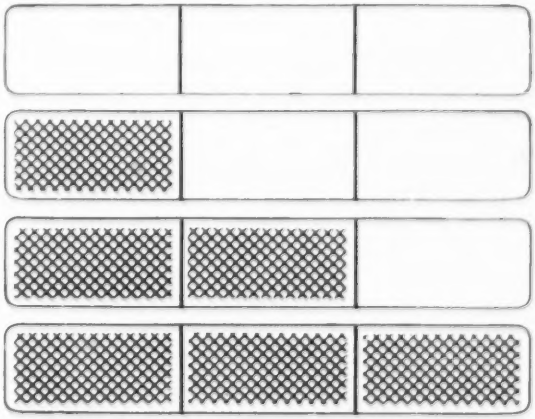
**Please color the bars as indicated.**

GREEN



YELLOW





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# GAMEPIECES FOR FAB

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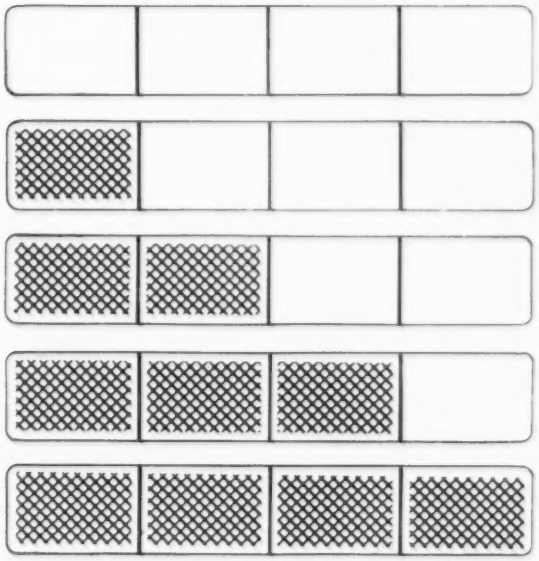
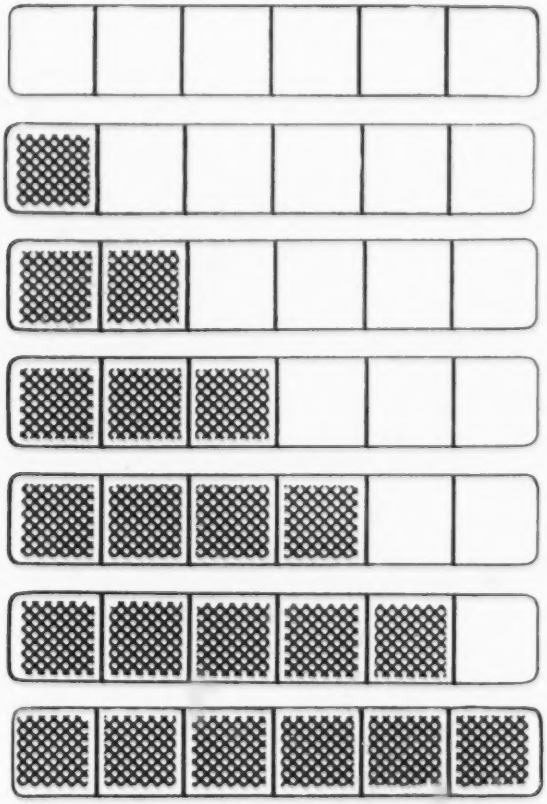
**Please color the pieces as indicated.**

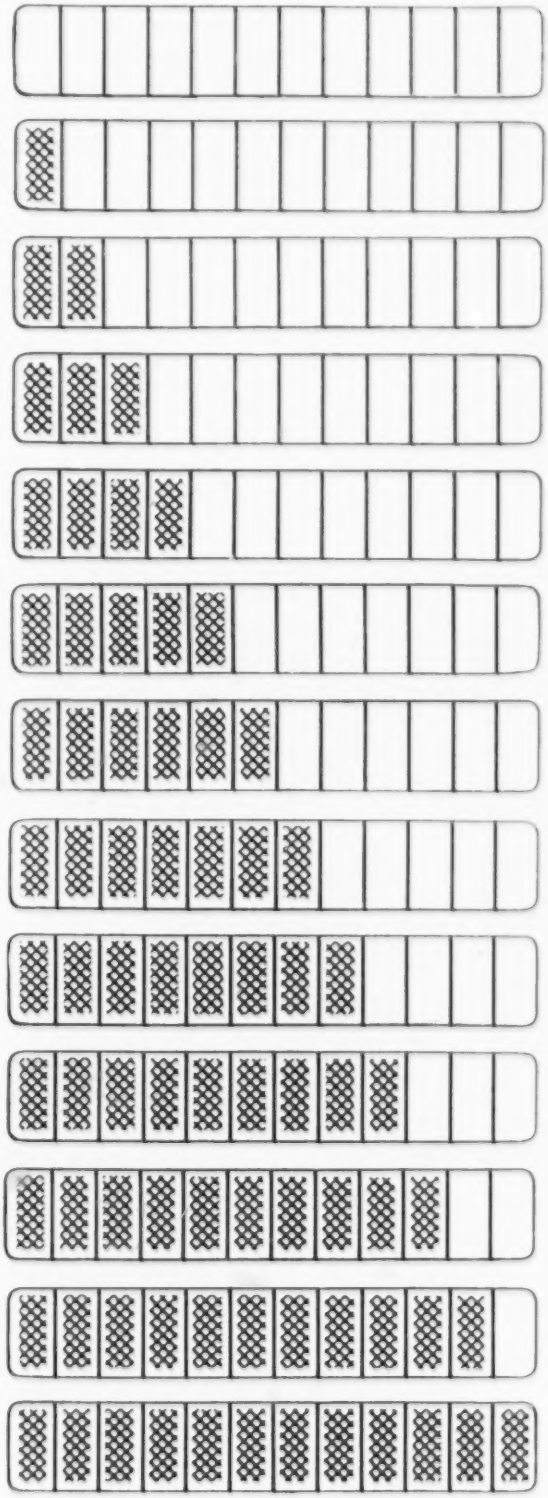
**BLUE**



**RED**



**ORANGE**



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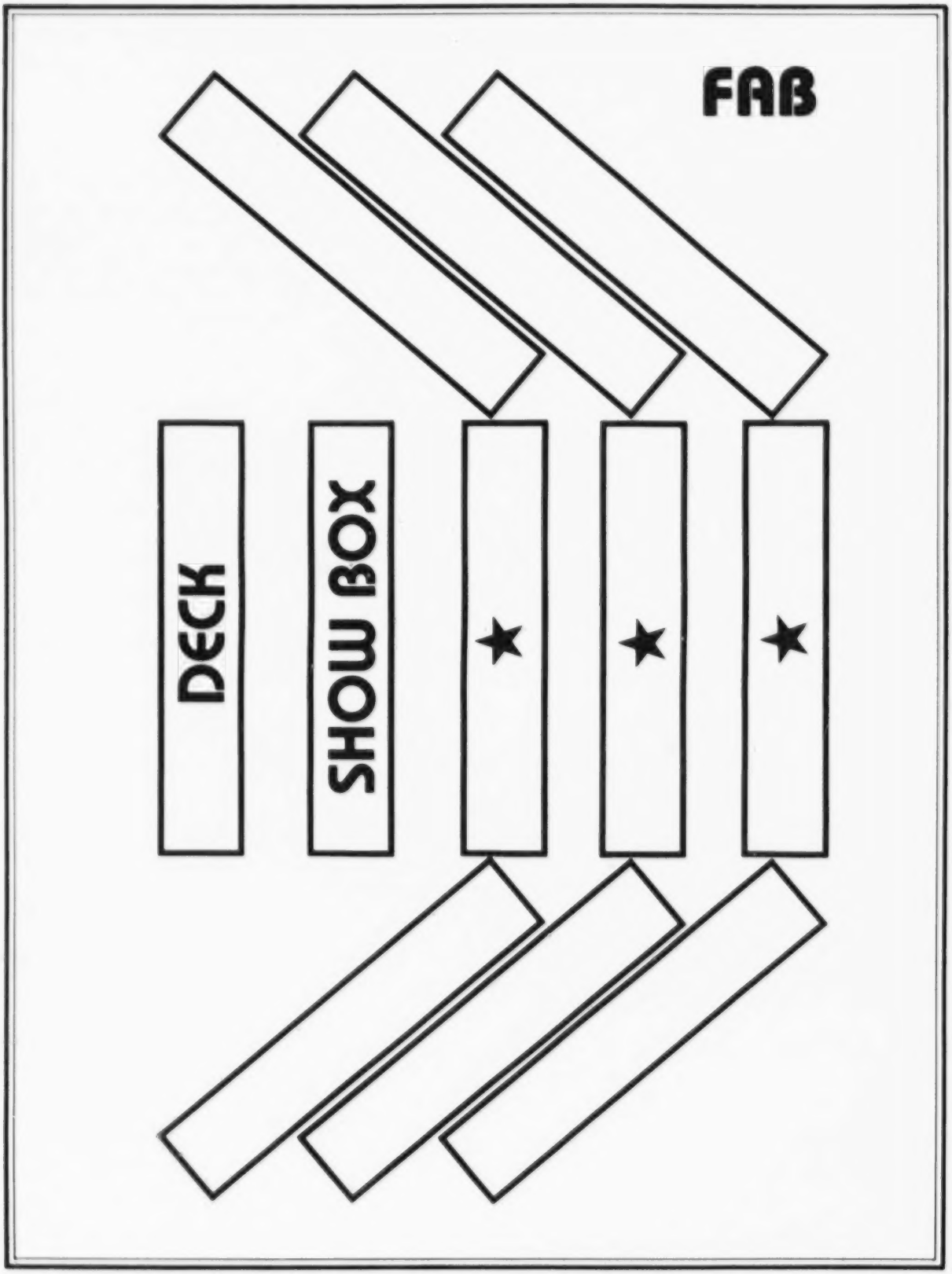


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*Based on a point system, the Mathematics Pentathlon® celebrates the accomplishments of* ***many*** *mathletes. Regardless of the outcome, all participants are considered "winners". One only "fails" when one does not attempt to grow. In this attempt, an individual may discover that an opponent contributed other insights that one did not consider. Indeed,* ***real learning*** *has just been experienced!*

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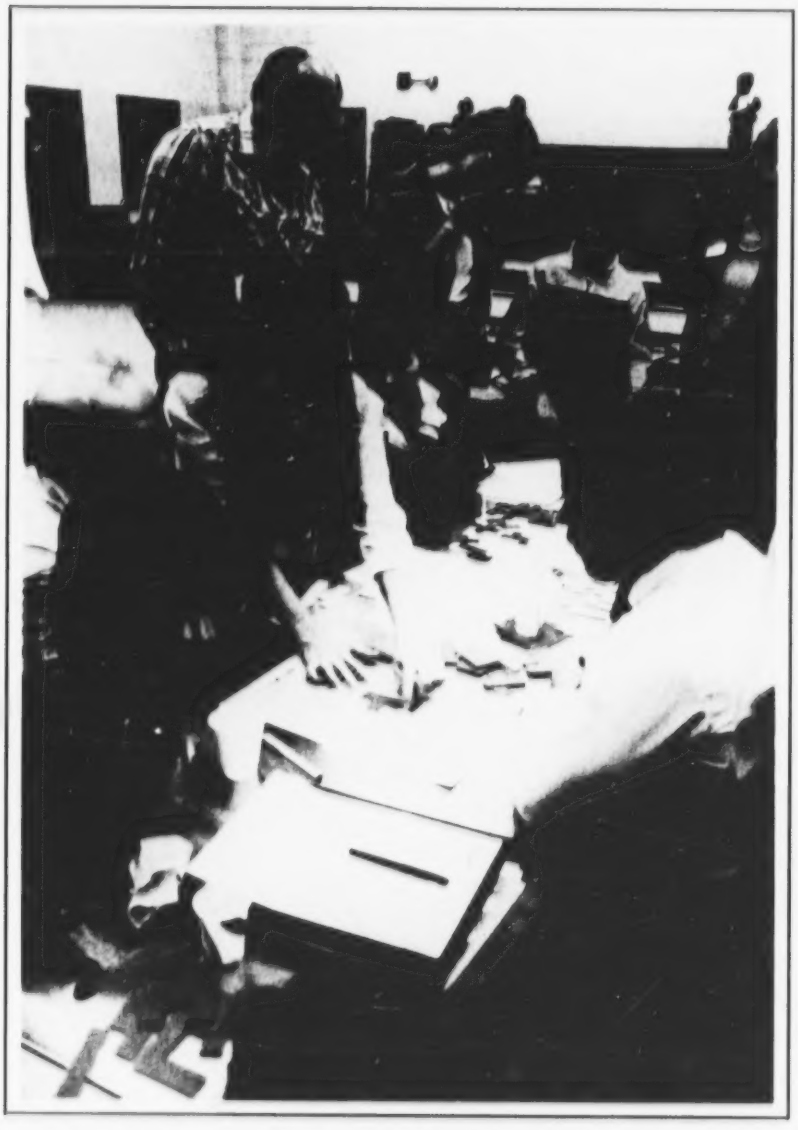

Orientation of parents, teachers, and administrators.





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**Paula Minton**
**One of our star volunteers.**

The Pentathlon Institute offers Mathematics Pentathlon® orientation sessions or special in-service sessions on teaching Mathematics Experienced-Based Approach (MEBA™). For further information please contact:


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